# THE AMERICAN GAS LIGHT JOURNAL

ROMAN & KENNY, N.Y.

PUBLISHING OFFICE No. 42 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXXVII. No 15. Whole No. 1,427. | NEW YORK, MONDAY, OCTOBER 13, 1902. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager. THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y AS SECOND-CLASS MATTER.

**Published** on each Monday of the year, at No. 42 Pine Street, New York.

**Telephone.**—2996 John.

**Collections** are invariably made directly from this office for subscriptions, advertisements, etc. We have agents to solicit the same, but they are not authorized to receipt for money.

**Terms of Subscription, Including Postage.**—For the United States and Canada, $3 per annum. European countries, $5 (£1—25 francs). All payments to be made in advance. Single copies, 10 cents.

**Correspondence.**—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

**The American News Company,** Nos. 39 and 41 Chambers street, New York, are agents for this JOURNAL. Newsdealers will send orders to them.

**Remittances** should be made either by post office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

**Books.**—We will forward by express, at publisher's lowest rates, any book—scientific or otherwise—to any address in the United States or Canada. We would suggest to our patrons that to avoid the risk and expense consequent on sending us the money (we do not send books C. O. D.), that orders for books be sent us through the Purchasing Department of the American Express Company.

*The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.*


## CONTENTS.

An Asterisk (*) denotes an illustrated article.


OFFICIAL NOTICE—
Thirtieth Annual Meeting, American Gas Light Association ..... 505

EDITORIALS—
Briefly Told ..... 506
Notes.
The Educational Problem, by Mr. J. A. Mayers ..... 507
Movements of the Flame in the Explosion of Gases, by Mr. H. B. Dixon, M.A., F.R.S. ..... 507
Electrical Supply from Water Power in Massachusetts, by Mr. A. D. Adams ..... 511
The Clay Working Industries of Greece ..... 512
*The Incandescent Burner in the Church, by Mr. J. H. Troughton 512
Laying Pipe Under Water and Submerged Suction Mains, by Mr. A. L. Holmes ..... 513
The Beaumont Oil Field, by Mr. Robt. T. Hill ..... 514

ITEMS OF INTEREST FROM VARIOUS LOCALITIES ..... 515
Personal—Company Incorporated—Gas for Niagara Falls, Ont.—Cheaper Gas for Rochester, N. Y.—Bond Issue, Peoples Company, Rutland, Vt.—To Prevent Coal Thefts—Personal—Mr. Patten in Full Charge at Manitowoc, Wis.—Proposed Company for Patchogue, L. I.—Bond Issue Retired, Altoona (Pa.) Company—Mr. W. E. Bellmer Takes Charge at Defiance, O.—Gas and Electric Rates, San Jose, Cal.—Personal—Gas Plant for Ensley, Ala.—Sale of the Alcion (Mich.) Company—More Ground Room for the Hartford (Conn.) Company—A Hint from Montreal, Quebec—Reorganization of the Winston-Salem (N. C.) Company—The Chemung County (N. Y.) Gas Company—And Many Other Items.

The Market for Gas Securities ..... 517


[OFFICIAL NOTICE.]

## Thirtieth Annual Meeting, American Gas Light Association.

OFFICE OF THE SECRETARY,
NEW YORK CITY, Sept. 1, 1902.

*General Announcement.*—There will be a meeting of the American Gas Light Association held at New York city, October 15th to 17th, 1902.

The meeting will be called to order by the President, Wm. R. Beal, of New York city, at 10 A.M., Wednesday, October 15th.

The meeting hall will be the breakfast room in the New York Athletic Club House, corner 59th street and 6th avenue.

The headquarters will be at the Plaza Hotel, 59th street and 5th avenue.

The most satisfactory quarters are always obtained by writing in advance to the hotel people, and in doing so a reply should be requested, for which a self-addressed, stamped envelope should be inclosed, as misunderstandings may thereby be averted.

The Plaza Hotel has guaranteed to accommodate 100 persons attending the meeting, at the following rates for rooms:

American plan: Single rooms $5 per day; double rooms, occupied by two persons, from $9 per day (that is, $4.50 for each person) and upwards. Some of these rooms have baths and some are without baths. The ones with baths will go to those applying first.

European plan: Single rooms, $2.50 per day; double rooms, occupied by two persons, $4 per day (that is, $2 per day for each person) and upwards. The remarks as to bath rooms on the American plan apply here also.

The Savoy and the Netherland Hotel, both situated at 59th street, on the opposite side of 5th avenue from the Plaza, have each guaranteed to accommodate 50 persons at the following rates, on the European plan:

Single rooms, without bath, $2 per day. Single rooms with bath $3 per day. Double rooms with bath, occupied by two persons, $5 and $6 per day (that is, $2.50 and $3 per day for each person). For those desiring suites there will be a limited number at from $8 to $14 per day.

An effort will be made to obtain rates from some other hotels in the vicinity, and, if successful, notice will be sent to the members before the meeting.

The roll call will be made by means of the door card system. Each member upon entering the hall for the first time will, at the door, receive a special card upon which he will find his name, address, etc., as it appears on the Secretary's books, and such card should be corrected and given to the doorkeeper. Members in attendance should attend to this very carefully, as these cards are used immediately after the meeting for correcting the annual membership list. Visitors will please hand to the doorkeeper their personal cards.

A blank form of application for membership accompanies this circular. More can be obtained of the Secretary.

Remember, all applications must be in the Secretary's hands by October 15th, at the very latest, otherwise they will not be acted upon at this meeting.


LIBRARY OF CONGRESS
OCT 13 1902

The list of papers to be read at the meeting is as follows:

"Some Notes on Cement Masonry," by Mr. I. N. Knapp, Philadelphia, Pa.

"The Care and Maintenance of Incandescent Gas Burners," by Mr. McDougald Dexter, Columbus, Ga.

"The Cleaning and Repairing of Gas Stoves," by Mr. Geo. S. Clarke, Kansas city, Mo.

"Gas Rates and a Franchise Tax," by Mr. Geo. McLean, Dubuque, Ia.

Also several other papers, the exact titles of which have not yet been decided upon.

If the papers are of a sufficiently high standard, the Beal medal will be awarded to the author of the best paper presented, the question of which is best to be decided by the proper committee.

The officers are endeavoring to arrange for a lecture on some subject of interest to the members, to be delivered during the meeting.

In addition to the papers and lecture, the report of the Research Committee will deal with the question of Pipe Standards, referred to the Committee at the last meeting, and with other subjects that should give rise to a good discussion; and there will be an interesting report from the Committee on Uniform Accounts. During the days of the meeting all the announcements will be posted on the bulletin boards at the headquarters and meeting hall. All members are warned to take notice thereof accordingly. All members attending the meeting are particularly requested to wear their membership badges in plain sight, thereby greatly aiding the officers and the local committee in their work, by affording a ready means of recognition.

In order that the "Year-Book," containing the report of this meeting, may be published and issued to the members immediately after the meeting, notice is hereby given that, if any of the speakers at this meeting desire to correct their remarks before they are printed, they will be given an opportunity before leaving New York city, but not after. The stenographer will have typewritten copy of the principal discussions prepared at the headquarters between the sessions of the meeting, and all those who desire to correct their remarks must notify the Secretary at the close of the session at which such remarks are made, as all the reports will be turned in to the printer immediately after the adjournment of the meeting.

[Here follows a detailed statement respecting the special rates for transportation—one fare and one-third, going and returning by the same route—that have been promised by the named Passenger Associations. These include the Trunk Line Passenger Association, the Central Passenger Association, the Western Passenger Association and the Southeastern Passenger Association. This series virtually means that any member of the Association may avail himself of the shortened fare under the certificate plan.]

*Special.*—The entertainment as now planned will include for the ladies a carriage ride on one afternoon and a theater party on the evening of the banquet. For the members there will be provided a banquet at the New York Athletic Club on Thursday evening, and parties will be organized to visit the various gas works, or some of the large electric power stations, or both, on Friday, and if possible an inspection will also be made of part of the work on the underground railway now building in New York at a point where this work has been practically completed. You will be notified later of the price of the tickets for the banquet and other entertainment.

Be sure to obtain a railroad certificate when buying your ticket for New York. The greater the number of certificates handed in, the easier it is to get the reduction in rates for future meetings, since the railroad officials count the certificates turned in as marking the full attendance. In our case the number of certificates is from 50 to 100 less than that of the persons in attendance, and our requests for lower rates are not given the consideration they should receive. Apply for ticket and certificate at least 30 minutes before train time. Each person must sign his own certificate at time of purchasing tickets for New York. Be sure to hand the Secretary your certificates, accompanied by 25 cents for each one, as soon as you reach the headquarters. Apply for return ticket at least 30 minutes before train time, and have your certificates with you. All persons, ladies included, attending the meeting are entitled to the reduced rates from the territories named. Members will please hand their certificates to the Secretary or his clerk upon arrival at place of meeting. If there are 100 members present, holding certificates, each certificate will then be properly indorsed and handed back to the owner before adjournment.

Any members having questions which they desire to put into the question box should send the same to the Secretary as soon as possible, in order to give him an opportunity to have them printed and distributed to the members before the meeting, so as to secure for them careful attention.

ALFRED E. FORSTALL, Secretary.

## BRIEFLY TOLD.

NOTES.——

NOTIFICATION was forwarded us under date of the 29th ult., from Mr. Walter King, editor and publisher of the *Journal of Gas Lighting*, London, England, and who is also the publisher of Newbigging's "Handbook for Gas Engineers and Managers," that the 6th edition of the book is out of print. Mr. King adds that, "Mr. Newbigging is pushing forward with the preparation of a new edition; but so far we have no copy in hand for the printers. It is not likely, therefore, that the book can appear before the early months of 1903."

MR. J. W. DUNBAR, Secretary of the Western Gas Association, writing under date of the 7th inst., says that the Holyoke (Mass.) Water Power Company, at the suggestion of its President, Mr. W. H. Snow, has presented to the Thompson Memorial Library of the Western Gas Association the complete testimony taken in the prolonged investigation of the Company's gas properties which the local authorities were anxious to take over for operation on municipal account. There are 19 volumes in the gift.

THE Stacey Manufacturing Company, of Cincinnati, O., has contracted for quite a number of holders to be completed early the coming year. Among them may be noted the following: A 1,000,000 foot vessel, to rest in steel tank, for the Capital City Gas Light Company, of Des Moines, Ia.; a 100,000-foot capacity holder for the Saratoga Springs (N. Y.) Gas, Electric Light and Power Company, and a 100,000-foot holder for the Fond du Lac (Wis.) Street Railway and Light Company. Both the small holders are to rest in steel tanks. The Stacey Company is in line with many others who are experiencing considerable trouble in getting material from the mills, but the Company will guarantee to perform its contract promises with despatch. Contracts have been let for the construction of a new plant for the Stacey Company, to be built at Elmwood Place. The establishment will consist of two buildings, one 500 feet by 200 feet, the other 200 feet by 50 feet. It is agreed that the plant, which will be equipped in the best systems of to-day, will be completed before the close of 1903.

THE authorities of Logan, O., have appealed to Judge Badger to hear testimony in support of a petition in mandamus against the Federal Gas and Fuel Company. Testimony over the issue was taken some days ago. The city of Logan claims that when the franchise was granted to the Company a provision was made that the city should not be charged for gas supplied for use on public account. When the Company was well underway it refused to furnish the gas on such account, alleging that the service could not be performed except at great loss. The city asks the court to compel the Company to live up to its agreement, failing which that a decree be entered annulling its franchise. Decision was reserved.

THE plant of the Clyde (N. Y.) Gas and Electric Company has been sold for taxes. The purchaser was Mr. W. J. Hayes, of Cleveland, O., one of the Company's bondholders.

IN the reorganization of the Nantucket (Mass.) Gas Light Company, the sale of the properties of which, to a syndicate headed by Mr. John W. Cawley, has heretofore been noted in the JOURNAL, the following officers were chosen: President, Almon T. Mowry; Treasurer and General Manager, John W. Cawley; Directors, A. T. Mowry, J. W. Cawley, W. S. Keene, A. M. Myrick and A. G. Bock. Suitable resolutions respecting the meritorious and lengthy services to the Company of its retiring Secretary and Treasurer, Mr. Andrew M. Myrick, were adopted. The plant is to be rebuilt.

THE proprietors of the New Haven (Conn.) Gas Light Company have granted the petition of certain of their works' employees for a nincrease in their rate of pay from 22½ cents per hour to 25 cents per hour.

FIFTY of the employees of the Washington (D. C.) Gas Light Company have formed an organization for "their better protection;" whatever that may mean.

IT is reported that the authorities of Chicago are or have been appealed to for a franchise that will enable the promoters of the Citizens Co-operative Gas Company to engage in business in that city. The main man behind the proposition is said to be Mr. R. H. Pugh, a wealthy retired iron merchant. The Secretary of the concern is Mr. W. R. Owen, of Oak Park. Its capital is named, "In any requisite sum; from $15,000,000 to $100,000,000," according to Mr. Pugh. The projectors propose to supply gas to ordinary consumers at 60 cents per 1,000 cubic feet, and to furnish gas to street lamps, on an all night and every night basis, for $14 each per annum. There is little likelihood that the franchise will be granted.

[Communicated Article.]

## The Educational Problem.

By Mr. J. A. Mayers, New York City.

Seventy per cent. of the students enrolled in the correspondence class of the American Gas Light Association drop out before completion of the course.

The last year of the five for which subscriptions were made to carry out this plan of education will begin this fall, and with such a showing it would not be reasonable to expect the same enthusiastic support for the next 5 years as in the past five, if it is proposed to conduct the class on the old lines. The system seems to be administered as well as that of any correspondence school; but are the system and results the best obtainable for the money expended?

The correspondence school in general has reached gigantic proportions, which accounts for the vast amount of good it has achieved; its percentage of good results, however, is small in proportion to the number taking such courses. To question broadly its right of existence would be futile, therefore at the beginning I wish to say that, generally speaking, it has my strong indorsement, on the theory that a correspondence school is better than no school; but against this system of long range education are the following disadvantages:

(1.) The work is done at night, usually after a man has put in a day's work of 8 or 10 hours; and although his efforts to study may be great, the benefit derived from it is small—physical weariness is coincident with, and a cause of mental inactivity. Of course, there are some men whose physique can stand the strain and still have energy enough for mental toil, but they are exceptional.

(2.) Intermittent study requires more time and greater effort to accomplish anything than continuous application, as the ordinary method of continuous teaching in our schools indicates. Writing questions and waiting for answers are apt to cause the student to lose patience.

(3.) The absence of personality is a great loss; not only that of the instructor, but that of others striving after the same end.

(4.) The absence of rivalry among students, which is produced as a rule only by personal association.

(5.) The impossibility of asking questions instanter, suggested by the last reply, and not asked on account of laborious correspondence.

(6 ) The lack of pleasure derived from solitary study other than gain of knowledge.

(7.) The injury done in discouraging students to again begin study after failure.

To overcome the objections enumerated above I would suggest that the time of the Secretary of the Association and the money now spent for education be devoted to what might be called "A moving gas summer school," either as a substitute for, or in addition to the present correspondence school, and based on the following lines:

*Location.*—At about five different centrally located cities in the United States.

*Time and Period.*—During the summer, and course to last from two to four weeks, for two years at each point, with daily studies.

*Courses.*—A beginner's, and an advanced course.

*Curriculum.*—Theorectic study of all branches of the gas business; practical demonstration with apparatus supplied gratis by manufacturers; practical chemical experiments with portable laboratory, and practice at local gas works.

*Preceptors.*—The Secretary of the Association to take charge of regular studies, and lectures given by neighboring gas men.

The advantages of such a system are apparent, but to enumerate them:

(1.) Having nothing to do but study, the men will absorb with ease and pleasure the knowledge to be imparted.

(2.) Continuous study will shorten its period, and an opportunity for immediate discussion is afforded.

(3.) The good effects of the teacher's personality will be felt.

(4.) The good effect of rivalry between students and the opportunity to discuss points of interest outside of recitation hours; and the closer acquaintance between men of the same profession.

(5.) The abolishing of unnecessary labor of correspondence.

(6.) The pleasure and incentive of studying and associating with other ambitious men.

(7.) Minimizing the possibility and number of failures.

*Expense.*—The additional costs to the Association over the present method would be very nominal, consisting of the Secretary's travelling expenses, investment in laboratory apparatus, and rental of class room, which latter, however, might be nil, as it may be possible that high school class rooms could be obtained free of expense.

*Students' Charges.*—Text books prepared by the Secretary, and laboratory expense. A charge may be made to all students who are able to pay it. And if men not employed by a gas company desire to take the course they should be admitted with proper charge.

*Attendance.*—A large number of gas companies see the wisdom of giving their employees a vacation with pay, and they could find no more pleasant nor profitable way of spending it than attending such a school. Such vacations could be arranged by the different companies to suit the school.

*Preparation.*—Preparatory reading should be indicated to prospective students, and an examination held at their homes to find out the status of their elementary knowledge before admission to the summer school is granted.

There may be fewer who would take this course, but also there would be fewer discouraged by failure, and I venture to suggest that those who have the patience and perseverance to wade through the present correspondence courses would find a way to attend the personal course in preference.

I would further suggest that this new plan be at least given a trial in a small way next summer near New York or Chicago.

## Movements of the Flame in the Explosion of Gases.

[Abstract of a paper read by Mr. Harold B. Dixon, M.A., F.R.S., at the last meeting of the Royal Society, England.]

I. *Historical Introduction.*—Bunsen, in 1867, made the first careful measurement of the rate of which an explosion is propagated in gases; and he also made the first systematic researches on the pressure and temperature produced by the explosion of gases in closed vessels. His results led him to the remarkable conclusion that there was a discontinuous combustion in explosions. When electrolytic gas, or when carbonic oxide with half its volume of oxygen, is fired, only one-third of the mixture is burnt, according to Bunsen, raising the temperature of the whole to about 3,000° C. No further chemical action then occurs until the gaseous mixture falls, by cooling, below 2,500° C. Then a further combustion begins, and so on, *per saltum*. These deductions were criticized by Berthelot, who pointed out that they assumed the constancy of the specific heats of steam and of carbonic acid at high temperatures. Bunsen also stated that the rapidity with which the flame of the explosion spreads is synchronous with the attainment of complete combustion and of the maximum temperature.

In 1881, Berthelot and Le Chatelier independently discovered the great velocity with which the flame travels in gaseous explosions. Berthelot showed that this velocity was a constant for each gaseous mixture, and compared the rate of the "detonation wave" (*l'onde explosive*) with the mean velocity of the molecules produced by the combustion before they had lost any heat. In the Bakerian Lecture for 1893, the author showed that Berthelot's theory did not account for many observed rates of explosion, and put forward the view that the explosion wave travelled with the velocity of sound in the burning gases. Using the rates determined by the author, D. L. Chapman has argued that, if the explosion wave is of a permanent type, an equation can be deduced from Riemann's formula by which the rates of explosion can be calculated if the specific heats are known, and *vice versâ*. The rate of the detonation wave may therefore be utilized, according to Chapman, to determine the specific heats of gases at very high temperatures.

In 1883, Mallard and Le Chatelier published their researches on the combustion of gaseous mixtures. Using a delicate indicator, they found that rapidly exploding gases gave very high pressures for very small periods of time. These high but fugitive pressures they attribute to the compression wave which is propagated as the inflammation spreads from layer to layer. To obtain the mean pressure of the ignited mass of gas, they had recourse to a less sensitive Bourdon gauge, and from the pressure curves so registered they calculated the maximum pressures and temperatures of the explosion. Their results may be summarized in the statement that the maximum temperature of the explosion of moist electrolytic gas is 3,350° C., and the mean specific heat of steam between that temperature and 0° is 16.6 (at constant volume), dissociation being very slight, if any, between these temperatures. On the other hand, the mean specific heat of carbon dioxide rises to 13.6 at 2,000° C., and above this dissociation begins. The simple diatomic gases ($O_2$, $N_2$, CO, etc.) show a rise of specific heat, though far less marked.

Berthelot and Vieille (1885) also determined the maximum pressures produced in the explosion of gases, and calculated the maximum temperatures. Their results were similar to those obtained by Bunsen; but they attribute the defect of pressure observed not to the inability of the

gases to combine at the temperature reached, but to the great increase of the specific heats of the products of combustion.

On the other hand, Dugald Clerk contended (1886) that in an explosion the combustion is never completed instantaneously; and since the burnt gases are cooling while the unburnt are still combining, the observed pressures and temperatures fall short of those calculated for instantaneous combustion.

Mallard and Le Chatelier were the first to record the movements of the flame in explosions by photography on a moving film (1883). Failing to obtain images of the flame with mixtures such as $2CO + O_2$, they employed carbon disulphide ($CS_2$) with oxygen and with nitric oxide. When the gases were ignited by a flame at the open end of a long tube, the flame was propagated along the tube for some distance with a uniform slow velocity. In the case of mixtures of carbon disulphide with nitric oxide, this period of uniform movement is succeeded by oscillations of the flame, which sometimes become of larger and larger amplitude and then die down, and sometimes give rise to the "detonation wave." When carbon disulphide is mixed with oxygen, the preliminary period of uniform movement is shorter, and is succeeded immediately by the detonation.

Mallard and Le Chatelier drew attention to the fact that in these explosions—starting at the end of a tube—the *development of the detonation wave is not progressive, but always instantaneous.* When the mixture was fired near the closed end of a tube, the movement of the flame was uniformly accelerated until the detonation is set up. Their apparatus did not move fast enough to analyze the more rapid movement of the flame.

In 1888, Von Oettingen and Von Gernet analyzed the flame by means of a rotating mirror. Their photographs reveal, they state, the phenomena immediately succeeding the chemical combustion. For although the flame of electrolytic gas appeared intensely bright, its spectrum only gave the sodium and calcium lines, and the most sensitive photographic plates showed "hardly a trace of the process." Failing to photograph the flame itself, the authors added finely divided salts to the tube, and found that the most brilliant pictures were given by cuprous chloride. Their pictures show the passage of waves sharply reflected backwards and forwards from the ends of the tube, and gradually diminishing in intensity and velocity. These visible waves, according to Von Oettingen and Von Gernet, are not a picture of the process of combustion itself, but are compression waves moving through the products of combustion after the explosion is completed. *The explosion itself,* they say, *is quite invisible.* Their photographs also show waves running nearly parallel with the primary waves. These secondary waves are particularly referred to as supplying conclusive evidence that *successive partial explosions* have taken place (starting from the electrodes) exactly as Bunsen imagined.

In 1884, Living and Dewar showed that the flame of an explosion in a glass tube exhibited the spectral lines of sodium and of calcium, and of iron when fired in an iron tube and examined end on. When metallic salts were introduced in the form of powder, the corresponding lines were visible in the spectroscope. They made the interesting observation that the red lithium line was *reversed* when the explosion was made to travel towards the spectroscope, and they interpreted this to mean that the front of the advancing wave is cooler than the following part.

I have examined the spectra of many explosion flames. The light produced by the explosions of electrolytic gas is mainly due to particles knocked from the glass. In the faint continuous spectrum shown by the flame, the calcium lines stand out prominently. When the explosion travels first through a metal tube joined to a glass one in which the flame is photographed, the light is more intense near the junction. One can see the stream of luminous matter carried out of the metal tube. The cyanogen explosions, however, give a continuous spectrum crossed by metallic lines and by the characteristic "cyanogen lines." The luminous particles, whatever their nature, follow very closely the movements of the gas in which they float. When the spectra of the explosion flames were photographed end on, I have never observed any reversal of a line in the advancing flame.

II. *Photographic Analysis of Detonation Waves and their Reflection.*—[In conjunction with E. H. Strange, B.Sc., and E. Graham, B. Sc.]—By throwing the image of the explosion tube on to a photographic film (Eastman's) fixed to a rapidly revolving wheel, we found that the flame could be sharply photographed, and its movements analyzed, without the addition of any metallic salts to the tube.

The first point noticed in the photographs were (1) the sharpness with which the luminosity is set up; and (2) the uniformity of the detonation wave. There is no evidence of any gradual heating up of the gases, but, on the contrary, the temperature appears to spring to its maximum with abrupt suddenness. The gas ignited by the detonation (including particles knocked off the tubes) remains luminous for some time after the wave has passed. Many of the photographs show very distinctly the movements of the gas *en masse*, as it follows up the detonation wave, comes to rest, and swings back again.

When the detonation wave hits the closed end of the tube, it is reflected back in a distinctly marked luminous wave, remarkable for its great luminosity. As this reflected wave starts back from the closed end, it has at first to meet the gas moving bodily forward in the wake of the detonation wave. As it continues backwards, the gas it meets has less forward motion, then becomes stationary, and finally travels back in the same direction as the reflected wave. It follows, therefore, that the velocity of the reflected wave is at first retarded and afterwards increased by the motion of the medium.

The reflected wave produced by the collision of a detonation wave with the closed end of the tube is mainly an intense compression wave. The velocity of the reflection wave may be readily compared with that of the detonation wave. In the following table, the average velocities observed in several gaseous mixtures are given, the velocity of the reflected wave being taken as nearly as possible at the point where the movement of the gas itself was *nil*:

TABLE I.—*Velocity of Reflection Waves in Gaseous Explosions.*

| Mixture of Gases. | Velocity of Explosion Wave in Meters per Second. | Velocity of Reflection Wave in Meters per Second. | Ratio of Velocities. |
|---|---|---|---|
| $2H_2 + O_2$ | 2,820 | 1,538 | 1.83 |
| $H_2 + N_2O$ | 2,305 | 1,383 | 1.67 |
| $2CO + O_2$ | 1,676 | 1,078 | 1.56 |
| $C_2N_2 + O_2$ | 2,728 | 1,230 | 2.22 |
| $C_2N_2 + 2O_2$ | 2,321 | 1,129 | 2.06 |
| $2C_2H_2 + 5O_2$ | 2,391 | 1,133 | 2.11 |

Although the formula for the velocity of sound in gases is strictly valid for small displacements only, nevertheless it appeared of interest to calculate from the observed velocities of these reflection waves what temperatures they indicated in the gas, on the assumption that they were propagated as sound waves. Of course, to calculate the temperature from the velocity of sound, it is necessary to know the ratio of the specific heats $\nu$; and since in the case of carbonic acid and steam this ratio is very doubtful, a corresponding uncertainty must exist in the temperature calculated. But in the case of cyanogen burning to carbonic oxide, the products of combustion, carbonic oxide, and nitrogen are similar to air, and their specific heats either do not alter, or do not alter greatly, with rise of temperature. The velocity of sound in such a gas would therefore give an approximation to the temperature.

Now the velocity of the reflection wave in cyanogen exploded with its own volume of oxygen is 1,230 meters per second. Assuming $\nu$ to be unaltered by rise of temperature, and the velocity of sound in air at 0° C. to be 333 meters per second, the temperature of the gas where the reflection wave was measured is given by the formula—

$$T = \left\{ \left( \frac{V\sqrt{\frac{d_1}{d}}}{333} \right)^2 - 1 \right\} 273 = 3{,}330° \text{ C.}$$

where V is the velocity of sound, and $d_1$ and $d$ the densities of the gas and air respectively under the same conditions. If, on the other hand, we assume (with Le Chatelier) that the specific heat at constant volume of diatomic gases rises with the temperature and becomes 7 at the temperature of this experiment, then the ratio $\nu_1$ falls to 1.29, and the formula becomes—

$$T = \left\{ \left( \frac{V\sqrt{\frac{d_1}{d}\frac{\nu}{\nu_1}}}{333} \right)^2 - 1 \right\} 273 = 3{,}672° \text{ C.}$$

In the case of cyanogen exploded with twice its volume of oxygen, the first reaction probably consists in the burning of the cyanogen to carbonic oxide, which combines more slowly to form carbonic acid. How far this second reaction is completed when the reflection wave is measured, it is impossible to decide. On the assumption that the specific heat of nitrogen is constant, and that $CO_2$ is 7.2, the velocity of the wave in the completely burnt mixture indicates a temperature of 4,200° C. On the assumption that the specific heat of $CO_2$ and $N_2$ are 20 and 7, the temperature indicated 4,780° C. On the other hand, if no $CO_2$ had yet been formed, the temperature indicated for the mixture of diatomic gases ($2CO$, $O_2$, $N_2$) is 2,880° C ($C_v = 4.8$).

In a similar manner, the temperatures corresponding to the velocity of the reflection waves have been calculated for the other mixtures, (1)

assuming the ratio of the specific heats for a diatomic gas to be 1.41, and for a triatomic gas 1.28; and (2) assuming the ratio of the specific heats for a diatomic gas to be 1.29, and for a triatomic gas 1.11:

TABLE II.—*Temperatures of Exploded Gases Calculated from the Velocities of the Reflection Waves.*

| Mixture. | I. $\nu$ for Diatomic Gas = 1.41. $\nu$ for Triatomic Gas = 1.28. | II. $\nu$ for Diatomic Gas = 1.29. $\nu$ for Triatomic Gas = 1.11. |
|---|---|---|
| $2H_2 + O_2$ | 3,720° C. | 4,830° C. |
| $H_2 + N_2O$ | 3,660° C. | 4,130° C. |
| $2CO + O_2$ | 4,530° C. | 5,250° C. |
| $C_2N_2 + O^2$ | 3.330° C. | 3,670° C. |
| $C_2N_2 + 2O_2$ | 4,200° C. | 4,780° C. |
| $2C_2H_2 + 5O_2$ | 3,980° C. | 4,630° C. |

A glance at this table reveals the fact that, whether the specific heats vary or not, but on the assumption that combustion is complete in each case, the explosion of cyanogen to carbonic oxide, which, according to all observers, gives the brightest flash and the highest pressure, also gives (apparently) the coolest combustion products a short time after the explosion wave has gone by. The natural inference to be drawn from these figures is that in those mixtures where steam or carbonic acid, or both, are produced, the combustion is not complete at the moment the reflection wave is measured.

III.—*On the Velocity of a Sound Wave in the Flame of Exploded Gases.*—[In conjunction with R. H. Jones, B.Sc., and J. Bower, B.Sc.] The interest attaching to the determination (even approximately) of the temperatures produced in the explosion of gases led us to attempt the measurement of the rate of a true sound wave (of small displacement) in the gases produced by the detonation wave.

In our first experiments, the glass explosion tube was fitted to a steel piece containing a tap of large bore and a small bye-tap, and connected by a pipe to a steel bomb, in which a small charge of fulminate could be fired. The bomb and connecting pipe were filled with air, while the tube was filled with a mixture of cyanogen with two volumes of oxygen. The lengths of the tubes were so adjusted that the sound wave, started in the bomb by the detonation of the fulminate, should be propagated through the air and cyanogen mixture, so as to meet the detonation wave coming in the contrary direction before the latter reached the end of the tube. The detonation wave was then photographed as it met the sound wave. The photographs clearly show several sound waves passing through the incandescent gases. The rates of these sound waves have been measured, and the corresponding temperatures calculated. These values are given in Table III. on the assumption that the combustion was complete:

TABLE III.

| Number. | Velocity of Sound Waves in Explosion of $C_2N_2 + 2O_2$. | Calculated Temperature. $\nu$ for Diatomic Gas, 1.41. $\nu$ for Triatomic Gas, 1.28. |
|---|---|---|
| 1st | 1,116 meters per second. | 4,100° C. |
| 2nd | 1,014 " | 3,330° C. |
| 3rd | 893 " | 2,530° C. |

It will be seen that the temperature calculated for the first sound wave (4,100° C) is in close accordance with that calculated from the reflection wave in the same mixture (4,200° C.) given in Table II.

The experiment was next varied by the introduction of a thin iron membrane between the air and the explosive mixture. The shock transmitted through the air from the fulminate struck the flexible plate, and so propagated a wave of small displacement through the explosive mixture. This wave had very little effect on the movements of the gas in the wake of the detonation wave; but its passage through the luminous gas was plainly marked. The gases were ignited as before, the lengths of the tubes being so adjusted that the first sound wave met the detonation wave about 1 meter from the membrane.

With the mixture $C_2N_2 + O_2$ three photographs were obtained in which the course of the sound waves was fairly marked. The mean of several independent measurements made on each photograph gave as the velocity of the sound wave *in the stationary gas* as 1,250 meters per second. This velocity corresponds to a temperature of 3,460° ($\nu = 1.41$), a number in very fair agreement with that calculated from the reflection waves—viz., 3,330° C. (Table II.) This agreement indicates that the reflection waves really travel with a velocity approximately equal to that of sound.

IV.—*On the Collision of two Detonation Waves, and the Effect of Junctions in the Tubes.*—[In conjunction with R. H. Jones and J. Bower.]—To study the effect produced in the collision of two waves of detonation, the explosion tube (of lead pipe) was bifurcated into two arms of epual length, which were bent round and held the two ends of a strong glass tube, in the center of which the two waves met. The joint between the lead and glass was made tight with india rubber. The photographs obtained with this apparatus were puzzling. Some of the "rebound waves" after the collision were much brighter, and travelled (backwards) much faster than the detonation waves themselves. Moreover, many photographs showed that the flame of the explosion had been affected by some impulses causing a sudden increase in its brightness and velocity, and producing a backward wave (analogous to a reflected wave).

The explanation of these appearances that first occurred to us was that the flame was preceded by invisible sound waves, travelling more quickly than the flame in its initial phases; that these sound waves became visible as soon as they met the flame moving towards them in the opposite direction (as in our previous experiments on sound waves); and that, on the other hand, the visible flame meeting the sound wave was affected by the sudden increase of pressure, and continued its journey with greater speed and luminosity. This explanation was at once destroyed when we found similar impulses in a flame which was sent through the apparatus in one direction only.

It next occurred to us that these impulses might be due to the explosion *catching up its own sound waves.* If sound waves are propagated through the gas from the point of ignition, the flame might lag behind the sound waves at first and catch them after a run more or less prolonged. The sound waves when overtaken might canse reflected sound waves (made visible in the luminous gases), and the explosion itself might become more intense owing to the collision. Many experiments were undertaken to verify or disprove this hypothesis; but finally it was found that the explosion was affected as it passed through the junctions between the lead and the glass, and the "impulses" recorded in our photographs were due to the detonation wave, damped down at the junction, being regenerated by fits and starts.

The flame is not retarded by turning round a corner, even when that is a sharp angle, nor is it damped down when the connecting junction is made of stout flexible rubber. After many trials, we found that the only thing which mattered was the rigidity with which the glass and metal were connected together. Any packing (such as rubber) which gave to a shock caused a retardation; when the glass was firmly cemented to the metal, no retardation occurred. The anomalies met with in our collision experiments were thus accounted for, and the examination of collisions between true detonation waves was proceeded with. When two detonation waves come into collision, the tube remains brightly luminous at the point of contact for some time, and two reflected waves are sent backwards with velocities which increase at first, owing to the movement of the gas through which they are propagated.

A comparison of all the photographs shows that the gases are more luminous after a collision than when the explosion wave strikes a flat surface of metal fastened at the end of the tube. The reflected waves in the two cases are similar in character, but the reflection generated by collision with another detonation wave seems always to travel slightly faster. If we were dealing only with waves produced mechanically, the reflected waves would be exact copies of the incident waves with velocities reversed—in both cases. But in the detonation wave, we have chemical as well as mechanical action, while the reflected wave is mainly mechanical. We should expect, therefore, the reflected waves to travel more slowly than the incident waves; but we should also expect the reflected waves to travel with the same velocity whether they were produced by collision with a rigid diaphragm or with a similar and equal wave travelling in the opposite direction—*unless there was some chemical difference involved in the two kinds of collision.*

Our photographs have shown that the wave of detonation has certain characteristics by which it may readily be recognized: (1) It starts suddenly, throwing back a strongly luminous wave through the burning gases, and leaving a dark space where it started. (2) It travels with constant velocity, unless it travels a junction not rigidly attached. After being damped down by such an obstacle, it recoups itself and again starts with abruptness. (3) On collision with a similar detonation wave moving in the opposite direction, or with a rigid diaphragm, it sends back a reflected wave not so rapid as itself, and as a rule not so luminous.

In the case of the more luminous explosions—*e.g.*, those of cyanogen, acetylene, and carbon disulphide mixtures—the reflected waves were less luminous than the detonation wave. But in the case of the less luminous explosions—*e.g.*, those of hydrogen and carbonic oxide—which depend largely for their light on the particles detached from the tubes, the waves reflected from a collision were sometimes more luminous than the detonation waves themselves.

V.—*On the Initiation of the Detonation Wave and on the Wave of Retonation.*—[In conjunction with R. H. Jones and J. Bower.]—Our photographs show abrupt changes in the acceleration of the explosion before the final spring which marks the detonation wave. These sudden changes are accompanied by a luminous wave thrown back through the ignited gases.

The strongly luminous wave thrown back from the point where the detonation is started we call the "retonation wave." A study of a number of photographs leads to the conclusion that the retonation is faster and more luminous when no other bright waves have been thrown back by the advancing flame before the point of detonation is reached.

The collision of two flames in which detonation had not yet been determined gave rise to reflected waves more rapid and more luminous than the incident waves. Now these reflected waves could not owe their increased velocity to the mechanical impact, which could only result in the reflected waves being copies of the incident waves. It is evident then that chemical action must occur to assist these reflected waves, and, therefore, the combustion is obviously not complete when these waves return. From this it would appear probable the period before the detonation is distinguished not only by a slower propagation of the flame—*i.e.*, of ignition—but also by a slower process of combustion.

At the point of detonation, the rapid rise of pressure produces not only the forward wave—that of detonation—but also a backward wave of compression into the gases still slowly burning behind it. This compression wave must raise the temperature of the ignited gases and quicken the residual burning; its propagation would thus be analogous to that of the detonation wave, but modified by the extent to which the slow combustion had proceeded.

The retonation wave attains its greatest rapidity and brightness when it is developed at the closed end of a tube—*i. e.*, when the gas is fired at such a distance from the closed end that the explosion, gradually increasing in intensity, just reaches the detonation point as it arrives at the stopper. Under such conditions, the reflected wave is superposed on the wave of retonation, and the result is a wave which cannot be distinguished from a detonation wave.

As regards the dark space formed at the point where the detonation and retonation waves originate, it is no doubt a space of cooler gas. It persists for some time, and its damping effect on the passage of collision waves can be observed in several of the photographs.

VI.—*On the Initial Phases of the Explosion.*—[In conjunction with R. H. Jones and J. Bower.]--As several of our photographs had shown that the flame in the period of acceleration was overtaken by a more rapidly moving wave, we photographed the *beginning* of an explosion of cyanogen with oxygen, and found that the bright flame which overtook the primary flame came *from the end of the tube near the firing wires.* The "kick-off" which the explosion gets from the closed end apparently enables the reflected wave to overtake the original wave of combustion. When the gases are fired by means of wires just penetrating the stopper closing the end of the tube, the explosion proceeds more slowly, and without disturbance by any sudden changes of acceleration until at last the point of detonation is reached. The photographs of these explosions are in marked contrast to those taken when the firing wires were 3 inches from the end of the tube. In the less rapid explosions, it is seen that the flame does not travel direct to the near end of the tube, but while still a short distance from it recedes and again approaches with an oscillatory motion, which is repeated before the flame finally reaches the end of the tube. From the point where the flame is first checked, a luminous wave is seen running back and overtaking the main flame, which at this point acquires greater brightness and velocity. From the point of collision, where the faster overtakes the slower flame, a reflection is thrown back to the near end of the tube, where it is again reflected.

Now, when an explosive mixture is fired by a spark, the suddenly ignited gases must expand and transmit a compression wave in both directions. This travels with the velocity of sound in the unburnt gas, and will be reflected from the end of the tube. The propagation of the flame from the firing point is, in most gaseous mixtures, less rapid than the velocity of sound in the unburnt gas; but the rate of propagation of the flame augments much more rapidly in some mixtures than in others. If the tube is a long one, the flame will overtake the sound wave after a more or less prolonged chase, according to the nature of the mixture. But if the tube is short, the sound wave may reach the end of the tube and return as a reflected wave to *meet* the flame, which is still advancing. Our measurements show this to be the origin of the "return wave" from the end of the tube.

When gases are fired in the center of a long tube, the phenomena of explosion are simple; when they are fired in the center of a short tube, the sound waves generated reach the end of the tube before the flames, and the impact of their reflections with the flames produces cross waves of great intricacy and beauty.

VII.—*Further Experiments on Initial Phases.* [In conjunction with B. Dawson, B.Sc., and L. Bradshaw, B.Sc.] 1. *Le Chatelier's Hypothesis of Discontinuity in the Explosion.*—Many photographs show a peculiarity at the point where a less luminous line is succeeded abruptly by a more luminous one. The lines photographed do not appear continuous, but the more luminous line appears to start from a point not yet reached by the less luminous one. The point of collision also of two waves appears to project in front of the waves which are meeting. It seemed to me at first as if these appearances might be due to invisible waves advancing in front of the visible ones; but as I found that they only showed where the luminosity of the lines was in marked contrast, and disappeared entirely when the films were not sensitive, or the contrast of luminosity was diminished, I came to the conclusion that the effect was due to halation on the photograph—the brighter lines being enlarged. But in 1890, Le Chatelier, relying on the same kind of evidence, put forward the view that the wave of detonation starts in front of the variable wave (which is increasing in velocity), and originates in an invisible wave which is proceeding in front of the visible wave, and with a velocity equal to it.

This definite judgment of the French experimenter compelled us to reexamine the question. We attempted at first to decide the matter by photographing an explosion as it passed from a less luminous mixture into a more luminous one; but we could not succeed in making the transition sufficiently sudden. We did, however, succeed in obtaining sudden changes of brightness by introducing a layer of Welsbach salts (a mixture of thoria and ceria), and having the rest of the tube quite clean. Although to raise the salt from the glass and to render it incandescent must take some time, nevertheless the photograph shows a small but distinct break in the line of detonation similar to that in question.

It is, of course, easy to show the enlargement due to brightness. If a tube is filled with a mixture giving a luminous explosion, and the explosion is photographed while half the tube is covered over, and if the the tube is then filled with a mixture giving a less luminous explosion, which is photographed on the same film while the first half of the tube is covered, a photograph is obtained which shows a greater discontinuity than any of those in question.

Another way of showing the same thing is to photograph a thin platinum wire stretched by weights, and rendered luminous by an electric current. If a second wire is brought to touch the first so as to divide the current, the portion of the wire which carries the whole current is more luminous than the other portion, and the photographs make it appear of far greater diameter.

The evidence against Le Chatelier's view may thus be summarized: (1) Its supposed effect is only seen when the contrasts are strong, and not on photographs of the same phenomena in which the contrasts are not brought out. (2) It can be initiated in various ways by means of contrasts. (3) The same effect is seen in the collision of two detonation waves; but Le Chatelier does not suppose that the "invisible wave" can precede the detonation.

2.—*Repetition of Von Oettingen and Von Gernet's Experiments.*—The very short time required for the explosion in electrolytic gas to raise the Welsbach oxides to incandescence was strong evidence against the view held by Von Oettingen and Von Gernet—viz., that the detonation of electrolytic gas is invisible, and that the salts present in their experiments only became luminous after the combustion had been for some time complete. Our previous experiments had also shown conclusively that the detonation is not set up at once, but only after the flame has run some distance, which varies with the nature of the mixture and the position of the spark. But, to place the matter beyond all doubt, we have repeated their experiments, using a tube of the same size and construction as theirs filled with electrolytic gas, but without the addition of any salts. By careful development, the course of the flame can be seen on the negatives from the firing wire. In all cases the explosion begins slowly, and has slight luminosity until the retonation waves are started by reflection from the ends of the tube. Some of our photographs closely resemble in detail those published by Von Oettingen and Von Gernet; but they show the initial movements of the flame, which are lacking in their photographs. The reflections of the two waves often run nearly parallel, but the stronger wave usually catches the weaker and coalesces with it. The photographs thus make clear how "secondary" waves running parallel with "primary" waves may be produced from a single explosion in a short tube.

## Electrical Supply from Water Power.

By Mr. Alton D. Adams, in *Elec. World.*

Massachusetts is not so liberally provided with great water powers as are some of the other New England States. Furthermore, the high density of population in this State and its numerous manufacturing interests tended to an appropriation of its most important waterfalls for other purposes, before electrical supply systems grew to be of importance. In spite of these facts, the considerable elevation of a large portion of the area of the State, which includes two watersheds, each extending across its entire width from north to south, and with a height above tidewater of 1,000 to 2,000 feet, and the numerous small rivers that flow down its slopes, offer many moderate water powers for the use of electric systems. These powers, often distant 5 to 20 miles from important centers of population, are rendered doubly available by the ease with which electrical energy is transmitted.

The object here is to point out the extent to which these small water powers, and, in a few cases, parts of the larger ones, have been applied to systems of electrical supply in Massachusetts. No mention is here intended of those numerous cases where an electric plant, devoted to the service of a factory or other private purpose, is driven by water power, but only those water-driven electric plants are considered which operate for purposes of public supply.

In a discussion of these plants it seems desirable to consider the steam engine capacity as well as the horse power of waterwheels included by each of them. Accordingly the accompanying table has been constructed to show the number and location of electrical supply systems in Massachusetts that use water power, and the capacity of steam engines and waterwheels in each:

*June* 30, 1901.—*Electrical Supply Systems in Massachusetts Using Water Power.*

| Name of Company. | Places Supplied. | Power Steam Engines. | Power Water Wheels. |
|---|---|---|---|
| Union S. Adams | Townsend | 50 | 30 |
| Attleboro Steam and Electric Co. | Attleboro | 750 | 79 |
| Central Mass. Electric Co. | Palmer, Monson, Warren | 450 | 735 |
| Franklin Electric Light Co. | Turner's Falls | .. | 100 |
| Great Barrington Electric Light Co. | Great Barrington | .. | 750 |
| Grafton Electric Co. | Grafton, Sutton | 75 | 109 |
| Holyoke Water Power Co. | Holyoke | 800 | 1,120 |
| Lawrence Gas Co. | Lawrence, N. Andover, Methuen | 1,415 | 1,691 |
| Lee Electric Co. | Lee | 205 | 145 |
| Medway Elec. Light and Power Co. | Medway | .. | 55 |
| Natick Gas and Electric Co. | Natick, Wayland, Wellesley | 875 | 710 |
| Orange Electric Light Co. | Orange | 185 | 408 |
| Rawson Light and Power Co. | Leicester | 210 | 30 |
| Shelburne Falls Electric Light and Power Co. | Shelburne Falls | .. | 85 |
| United Electric Light Co | Springfield | 1,650 | 2,835 |
| Weymouth Light and Power Co. | Weymouth | 820 | 400 |
| Winchenden Elec. Lt. and Power Co. | Winchenden | 125 | 150 |
| Municipal Plant | Middleborough | 150 | 125 |

Inspection of this table shows that 18 electrical supply systems, distributing energy in a somewhat greater number of towns and cities, are now operated entirely or in part by water power. Four companies, the Franklin, Great Barrington, Medway and Shelburne, depend entirely on water power, and have wheels with an aggregate capacity of 990-horse power. The largest of these purely water-driven plants is that at Great Barrington, with wheels of 750-horse power capacity. Much the largest application of water power to a public electrical supply system in the State is that at Springfield, where the wheels have a capacity of 2,835-horse power. Of the 14 plants using both steam and water power, 7 have greater capacities each in waterwheels than in steam engines, indicating probably that much the greater proportion of the total load, on an average, is carried by the water powers.

This conclusion seems to follow from the fact that where the capacities of wheels are such that they require the entire flow of a stream during periods of high water, they cannot be operated at their full power for the whole year. If the load of electric generators on waterwheels is kept nearly up to the full capacity of the latter, as is desirable, it follows that quite a large per cent. of the total waterwheel capacity must be represented in the power of reserved steam engines. Where the engine capacity is less than that of waterwheels in a plant, and a large per cent. of the engine power must be held in reserve for periods of low water, the capacity of engines for which a load can be found during periods of ample flow must be relatively small, under ordinary conditions.

For the seven plants where the capacities of waterwheels exceed those of engines in each case, the total for engines is 4,700, and for waterwheels 7,048-horse power. In the seven plants where the engines have the greater capacities, their total is 3,060-horse power, and that of the waterwheels 1,519-horse power. Engines aggregating 7,760, and waterwheels 8,567-horse power are included in the fourteen plants, a total of 16,327-horse power. If the powers of these wheels are reduced one-third in times of scant water, $8,567 \div 3 = 2,855$-horse power of the engine capacity must be held as a reserve, so that the maximum load for these plants in the dry season may only be $16,327 - 2,855 = 13,472$-horse power. Of this maximum the waterwheels will then furnish 42 per cent., and the engines 58 per cent.

For periods when the flow of water is ample, which is true during about two-thirds of the year, if the maximum load remains the same as before, the waterwheels carry 64 per cent., and the engines 36 per cent. of the load. Considering the output of energy for the entire year on this basis, the waterwheels supply $.33 \times .42 + .66 \times .64 = 56$ per cent. and the steam engines $.33 \times .58 + .66 \times 36 = 44$ per cent. of the total. It is good practice to provide steam power in excess of the maximum load, to an extent exceeding one-third of the capacity of the waterwheels, in order to be sure of sufficient reserve in very dry seasons. This practice would tend to increase the portion of the total yearly output of energy supplied from waterwheels in these cases. Including the four electrical systems operated entirely by water power, the total capacity of the wheels engaged in this service in Massachusetts is 9,557-horse power. With efficiencies of 75 per cent. for the turbines and 90 per cent. for the electric generators, this wheel capacity is sufficient for an output of 4,836 kilowatts.

Application of water power to electrical supply has gone on much faster than the general growth of the industry. In Massachusetts, during the fiscal year of 1889, water power was employed in four systems of electrical supply, but in 1901 this number had increased to eighteen systems. In the former year the total capacity of waterwheels in use by electric lighting systems was only 545-horse power. For 1901 this total stood at 9,557-horse power, or 17.5 times the capacity in the earlier year. Up to and including 1894 the application of water power went on rather slowly, the total being 2,085-horse power in that year, but since then progress has been more rapid.

*Horse Power of Waterwheels.*

| | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. |
|---|---|---|---|---|---|---|
| Holyoke | 370 | 370 | 370 | 1,120 | 1,120 | 1,120 |
| Middleboro | 125 | 125 | 125 | 125 | 125 | 125 |
| Turner's Falls | .... | 40 | 40 | 100 | 100 | 100 |
| North Attleboro | 30 | 30 | 30 | 30 | 40 | 40 |
| Lee | .... | 60 | 60 | 60 | 60 | 60 |
| Leicester | 20 | 60 | 60 | 60 | 60 | 60 |
| Natick | .... | .... | .... | .... | 140 | 280 |
| Palmer | .... | .... | .... | .... | .... | 300 |

| | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. | 1901. |
|---|---|---|---|---|---|---|---|
| Middleboro | 125 | 125 | 125 | 125 | 125 | 125 | 125 |
| Holyoke | 1,120 | 1,120 | 1,120 | 1,120 | 1,120 | 1,120 | 1,120 |
| Turner's Falls | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Lee | 60 | 60 | 60 | 60 | 145 | 145 | 145 |
| Leicester | 60 | 60 | 30 | 30 | 30 | 30 | 30 |
| Natick | 560 | 180 | 430 | 430 | 430 | 710 | 710 |
| Palmer | 360 | 360 | 360 | 510 | 510 | 735 | 735 |
| Grafton | 116 | 109 | 109 | 109 | 109 | 109 | 109 |
| Gt. Barrington | 640 | 640 | 640 | 640 | 750 | 750 | 750 |
| Attleboro | 40 | 79 | 79 | 79 | 79 | 79 | 79 |

| | 1896. | 1897. | 1898. | 1899. | 1900. | 1901. |
|---|---|---|---|---|---|---|
| Orange | 150 | 408 | 408 | 408 | 408 | 408 |
| Springfield | .... | 1,890 | 2,835 | 2,835 | 2,835 | 2,835 |
| Shelburne Falls | .... | 85 | 85 | 85 | 85 | 85 |
| Townsend | .... | .... | .... | 30 | 30 | 30 |
| Medway | .... | .... | .... | 56 | 55 | 55 |
| Winchendon | .... | .... | .... | 150 | 150 | 150 |
| Lawrence | .... | .... | .... | .... | 1,691 | 1,691 |
| Weymouth | .... | .... | .... | .... | 400 | 400 |

During the 5 years from 1889 to 1894, the capacity of waterwheels added to electrical supply systems was 1,540-horse power, or an average of 308-horse power yearly. In the 7 years from 1894 to 1901 the

added waterwheels amounted to 6,472-horse power, or 924-horse power in each year on an average.

Up to 1896 the electrical system at Holyoke had the largest capacity of waterwheels of any in the State, namely, 1,120-horse power; but in 1897 Springfield installed wheels of 1,890-horse power and took first place. It is a notable fact that no system which has once used water power has abandoned it. The small plant at North Attleboro up to 1894 was moved to Attleboro thereafter, but continued to use water power. Of the 18 plants recorded, 10 have increased the capacity of their waterwheels since first installed. The 3 plants at Holyoke, Springfield and Lawrence represent a combined capacity of 5,646-horse power in waterwheels. And this is only the beginning of water power in electrical supply.

## The Clay Working Industries of Greece.

The modern pottery of Greece is principally of two kinds, viz., ordinary, cheap crockery ware, for common or general use, and fine ceramic pottery, artistically made and finished by men who have studied the art at the Polytechnium, and who model their work after the celebrated ancient pottery of Greece, imitating the shape, colors, finish, etc. Some of these clay workers become very proficient, and make fine imitations of many of the ancient styles. In the preparation of the clay for pottery, brick, or tile, the Greeks sometimes mix it by hand, but often in a simply constructed clay mixer, turned by horse power. The ordinary or common pottery is very cheap, and is used for all kinds of culinary and household purposes. Jars, jugs, vases, bowls, basins, pots, etc., of a reddish color, and usually unglazed on the outside, but glazed within, are in general use, and can be bought at very low prices. In many places, but especially, says the United States Consul at Athens, on the Island of Ægina, a cream colored water jug or jar is made, which is so porous that when filled with water the moisture keeps continually exuding to the outside and there evaporating, which wonderfully cools the contents, especially when the vessel stands in the air. These cheap "water coolers" are used by every one, rich and poor, and great numbers of them are manufactured and sold every year. These jars are very cheap, but friable. Many thousand jugs of the red ware are continually in use for carrying and holding water. Pottery manufactories are very numerous in Greece. In Athens there are a dozen or more, the most noted of which are in the "Keramiekos" (clay workers) quarter in the western portion of the city, and on the "Sacred Way" of the ancients. They turn out many kinds of crockery, and some very good imitations of acient vases, etc. In the Cyclades, and in all the islands of the Ægean Sea, there are pottery manufactories, and the pottery of each island has certain characteristics peculiar to itself, owing to the difference in the clay, or the method used in its manufacture. Roofing tiles are manufactured in immense numbers in Greece. In and near the cities and large villages there is scarcely any other kind of roof in existence, but in the mountain villages some of the roofs are covered with flat stones, or slabs of stone. Tiles are manufactured in or near every city or town of any size in the kingdom, suitable clay for the purpose being plentiful and widely distributed. The tiles are made by hand, the only machinery used being a simple and primitive "mixer," turned by a horse or mule, which mixes the clay in a pit in the ground. With the exception of those situated in and near Athens, the outfit of the Grecian tile manufactories is neither elaborate nor costly. A tile manufacturer of the smaller towns can often carry his entire plant on the backs of two or three donkeys, and thus move from village to village where there is a demand for tiles.

Drain tiles and chimney tiles are made in considerable quantities. Nearly all the chimneys on dwellings in Greece are simply tiles built into the walls of the building, and extending to 3 feet above the roof. Ventilators are made in the same way.

With the exception of those producing marble, of which there are many good varieties, magnesite or other minerals, the mountains of Greece are principally limestone. Very few cities or villages of the kingdom are far from a limestone quarry, and the houses are frequently built of this material, many of the best buildings being faced or ornamented with marble. Most of the houses, however, are built of stone and stuccoed on the outside—and often on the inside—and painted in good imitation of marble. The stucco lasts many years on the exterior of buildings in Greece, where frost is seldom seen, and is cheaper than marble.

In some country villages, where the quarries are very far away or the roads are bad, houses are often built of sun dried brick, but in parts of Northern Greece, especially in the small villages of Thessaly, houses are built by first erecting a frame of willow poles and rods and then covering this wicker work with a coating of mud or clay mortar. Sun dried bricks are use in considerable quanties. The humbler houses in the suburbs of the cities of Athens, Piræus, Patras, and in many villages where stone is not plentiful or easy of access, are built of sun dried bricks. In fact in some villages the houses are nearly all built of this material. Many fences or walls throughout the country are composed of blocks of clay one yard square and half a yard thick, made in a manner somewhat similar to the manufacture of sun dried bricks. The bricks, as the name implies, are dried by the heat of the sun only. They vary in color, according to the color of the clay used, and measure about 12 x 6 x 2½ inches. These bricks are made in every village, town and farm in Greece that has clay, and there are few places in the kingdom that have no clay deposits. Kiln dried or burned bricks are manufactured in or near Athens, Volo, Chilkis, Pyrgos, and elsewhere in Greece; they are of a hard quality and usually of a very light cream color.

It is said that no soft kiln burned bricks are made. Kiln burned bricks are used for the erection of chimneys in factories, foundries, etc., partitions in buildings, bakers' ovens and furnaces, and sometimes for building drains and sewers. Iron chimneys or "smoke stacks" are seldom erected. On account of the limited use of kiln burned bricks in Greece, the manufacturers of this material are few. There are but four or five of importance, and even these do not make bricks exclusively—they also manufacture tiles. Like the sun dried, the kiln burned bricks are made by hand, the only machinery used being the simple "mixer" propelled by horse power. One man can mould 3,000 bricks each day. After the bricks are moulded they are allowed to be in the sun until partially dried, and stiff enough to handle easily. They are then built up in an "open work" manner, so that the heat from the fire can reach each brick. The fuel used is nearly always wood, and the fire, never very hot, is kept up for about fifteen days.

## The Incandescent Burner in the Church.

By Mr. J. H. Troughton, of Newmarket, England, in *Journal of Gas Lighting.*

The subject of the lighting of places of worship is one which should have the special attention of all gas managers, for several reasons which are so obviously advantageous that I need not particularize them. But in the hope that they may be of use to some of my fellow gas managers, I have put together a few notes as to the experience I have gained in successfully lighting up some of the churches of Newmarket with incandescent burners.

In the first place, I may say that, in my opinion, the incandescent burner is admirably adapted for this purpose, especially when the existing church fittings are suitable for either Kern or "C" burners, when they can be utilized at small cost, and effect a great saving in the consumption of gas; while the illuminating power can be increased to any desired extent by the number of burners fixed.

The first church I lighted was St. Mary's, Newmarket, which was previously lighted by means of drop-rings or pendants suspended from the center of each arch in the nave. But these were considered too mean for having incandescent burners fixed on them; so the Vestry took my advice, and consented to purchase new coronas of a simple yet tasteful design, being of polished brass, each having 3 arms and harmonizing with the surrounding church furniture. On each of these arms a No. 3 Kern burner was placed, fitted with opal globes, with clear bases—and, there being 6 arches on each side, 12 triple coronas were substituted for the 12 old-fashioned rings which had 4 flat flame burners on them—thereby considerably beautifying the church, as they look well even when not lighted.

For the chancel, the existing 24 flat burner corona was converted to take 4 No. 3 Kern burners. Two arches on one side, and one on the other side, had fixed on them coronas, burners, and glass similar to those in the nave. But it was found impracticable to fix a corona in the arch opposite the organ, on account of the organ pipes; so 2 No. 3 Kern burners were placed on suitable brackets fixed to the pillars, and these effectively light the organ, choir and chancel.

Thus in the nave 48 flat flame burners were replaced by 36 No. 3 Kern burners, and in the chancel 15 No. 3 Kerns replaced 40 flat flame burners, or, in all, 51 Kern burners replaced 88 common burners, which I estimate formerly consumed about 450 cubic feet per hour, as compared with the 51 Kerns, consuming about 150 cubic feet of gas per hour; while the light given by the new system is nearly three times as much as there was previously. The illustration shows the form of corona adopted.

The actual consumption during the first complete quarter bears out my estimate as follows:

| | |
|---|---|
| 88 flat flame burners in use for the quarter ended March 31, 1901, $34.18. | 51 No. 3 incandescent Kern burners in use for quarter ended March 31, 1902, $7.85. |

The following quarter, ended June 30, compares in about the same ratio.

The new system has satisfied all connected with the church. The atmosphere has not been vitiated as it was before; and during the summer the church was comfortably cool, the incandescent burners creating sufficient heat to promote healthy ventilation. Each corona is fitted with a cock; but these are seldom used, as on each side of the nave, and in the chancel, separate cocks are placed, which control the sections mentioned, and regulate the gas so effectually as to prevent the burners hissing. No governors are employed; nor are they necessary, as the above mentioned arrangement of cocks (which were previously in use) are quite ample for regulating or controlling the gas pressure.

It is interesting to note that the two cocks which are fixed on a 1¼-inch rising feed pipe to supply each side of the nave, have a small bye-pass of ¼-inch tube, fitted on with a ¼-inch cock, formerly used to turn the gas down for purposes of economy, is now found to pass sufficient gas for the 18 Kern burners. This points to the fact that consumers who formerly could not get sufficient gas through small and inadequate gas pipes for flat flame burners, can now get quite sufficient for the supply of incandescent burners. It must not be inferred from this that I advocate leaving existing small fittings alone, as it is more important than ever to-day to pull out inadequate pipes, and insert larger ones; for while we are reducing our customers' bills by recommending incandescent gas burners, we must not overlook the fact that the great bulk of gas required in the future will be for heating and cooking.

The cost of fitting up the church described was about $250. Two other churches have adopted exactly the same system after seeing it installed at St. Mary's. In one of them no other regulation is provided beyond the ordinary main cock; and this is found to be ample when about three parts turned off.

The third church is being fitted up at the present time with ten 3-arm coronas, but with No. 4 Kern burners. The existing chancel corona is to have 6 No. 4 Kern burners fixed upon it, at a cost of $193 75, complete with new fittings; and this contract was won in competition with the Electric Light Company, who offered to wire the church free, charging an extra cent per unit for current used, or 15 cents. I may here say that it is doubtful whether my Company would have obtained this order had I not been able to point to the experience gained in lighting the first church, and guaranteeing to give them a far better light than they obtain at present at less than half the cost that they have been paying; and I am perfectly certain this can and will be accomplished.

I do not think it a good plan to put incandescent burners on standards in churches where it can be avoided, owing to their being so liable to vibration. At the same time, I know of churches where this has been done with fairly satisfactory results, so far as economy and upkeep are concerned. At St. Mary's Church only 6 mantles were renewed in the first 6 months of this year.

## Laying Pipe Under Water and Submerged Suction Mains.

[From a paper read by MR. A. L. HOLMES, at the Indianapolis Convention of the Central States Water Works Association.]

Perhaps there is no more perplexing condition presenting itself to a water works manager or superintendent than a deep stream which it is necessary to cross with his main. On land he can carefully inspect and observe every detail of pipe laying, and see that the specifications in regard to tamping and backfilling are rigidly complied with, but when he lays a line under water he must rely upon the honesty and sense of feeling of the diver. Incased in brass and rubber, weighted with a hundred or more pounds of lead, living in compressed air, and seeing at the best in clear water as one sees as in moonlight, it is only natural that divers' work is not always reliable.

Many of the faults and the faulty work done by the diver and much of the time consumed could be excused if we tried to realize the difficulties under which he labors in trying to repair leaks and broken pipes at the bottom of streams single handed, when if he tried to do the same work on the ground above water he would have a hard task if incased in the same suit.

About the only safe way for laying pressure pipes across navigable streams is to place them in a trench well below the bottom of the river, and pipe carefully laid in this way will give no trouble. If the bottom is soft there is little trouble in dredging a trench. If it is rock, it can be drilled and blasted from the surface and the loose rock cleaned out of the trench, the most of it from above, but it will pay to send a diver down to be sure of a clean channel before sinking the pipe.

In some localities with soft bottoms it has been a custom to lay the pipe on the mud with the upper ends disconnected and then by a sand pump working along the line of pipe gradually work it down to place. Where this can be done in sand or mud, the pipe will keep in the bottom of the trench and thus save the handling of some material. At Michigan City, Ind., a 10-inch force main across the harbor was lowered from a depth of 16 feet 5 inches to a depth of 20 feet by the use of a sand pump and without any repairs whatever. This pipe was 100 feet long and was fitted with 5 ball joints, and together with 1,200 feet of other pipe on shore showed a leakage under 100 pounds of water pressure of only 168 gallons in 24 hours. A 16-inch riveted pipe across the stream at Hammond, Ind., was lowered in this way by the use of a water jet and was perfectly tight when lowered. Of course, I do not advocate this way of doing the work where it is practicable to get and to maintain a trench otherwise, but some streams are so swift and carry so much fine sand or silt that the trench would fill as fast as dug.

My preference for submerged pipe is cast iron hub and spigot pipe, with lead joints and every 36 or 48 feet a flexible joint that will allow of considerable movement. The Ward joint is perhaps as well known in this country as any of the various forms and was for quite a number of years the only one. During the last 20 years half a dozen others have come on the market and the price has been largely reduced. Originally in using the Ward joint, which is made in the end of 12 feet lengths of cast iron pipe, it was the custom to use such joints on the whole line of submerged pipe, but this was not necessary and incurred a needless expense.

Wrought iron pipe is used to a large extent by private concerns and there is a sufficient spring to a 6-inch wrought pipe with severed joints to conform to a surface that is quite uneven. A flanged cast iron pipe for this work will be expensive to lay and probably cause trouble from leaks. With medium sized pipe, say up to 12 inches in diameter, the work of jointing and getting in place can be done above water. In one case under the writer's charge a line about 200 feet long was sunk in 20 feet of water, being lowered from the sides of scows by ropes. It showed no leaks at the time, neither has it in the 18 years since it was placed.

Of course many, or the most of these submerged pipe lines, do leak unknown to the water works managers, and the best way to ascertain the amount of the leakage is by placing a valve at each side of a river crossing with a by-pass around it in which to place a meter. With the valves closed and a pressure on the meter the leak can be measured quickly. To locate the leak, I have found the use of an air pump the most efficient and the quickest means. With the valves closed and the air under pressure introduced into the submerged pipe, the air bubbles coming to the surface will locate the leaky joints very quickly.

In many streams in the interior, where there is no interference by boats, pipes are jointed on a frame of timbers sloping towards the stream, and as each length is added the pipe is launched into the water. The outer end is supported by floats, and as the pipe goes out floats are added about every 24 feet, until the whole line is put together, and it is then gradually lowered by long screws or ropes to the bottom. Cast

iron 12-inch pipe can be handled in this manner for about $1 per foot, including the lead used for joints, and it will cost about as much for the smaller sizes and but little more for 16-inch pipe. In some small streams, and moderate depth of water, I have used benches built of timbers, set in the ground or bottom of the stream, putting the pipe together on these platforms. It is easily lowered to the bottom, and I have personal knowledge of many lines that have been laid in this manner and have given no trouble.

The laying of pipe in cofferdams enables good work to be done, but it is generally very expensive.

In laying 24, 30 and 36-inch pipe in deep water, I have connected 40-feet lengths, with lead joints in the usual manner, placing on each end of this section half of a bolted ball joint, and lowering this into the trench prepared for it, holding one end off the bottom with a piece of wood 8x8 inches placed under the hub as the pipe was lowered to place. The next section prepared in the same way is lowered to place, and while in the slings and held just clear of the bottom the diver enters the ball into the bell and bolts it up. Pipe can often be laid in this way at the rate of 500 feet per day.

Bulkheads are placed over the ends of the pipes before they are placed in the water to exclude fish and rubbish while lowering, and are removed by the diver and sent up for use again. It is not necessary to keep pipe absolutely in line. If it zig-zags a little it may keep tighter if it settles. In river crossings, a curve up stream is generally desirable, so that as the current washes out under it and it works down stream it will become tighter.

At the end of suction pipes in lakes, I advoeate the submerged crib or intake, and in most cases I believe wood for this purpose is cheaper and preferable. In the Great Lakes, where there is navigation, I should advocate placing the outer end of the intake in 40, or preferably 50, feet of water. There is much less danger of obstruction to the water supply if a submerged crib is used than if it reaches above the surface. A crib of timber 24 feet square and 8 feet high, with a timber bottom and pockets loaded with stone (if no piles are necessary), can be placed for about $1,200.

Just as efficient protection is furnished by an upturned elbow on the end of the pipe, in which is inserted a tee of the same size; the ends of this are barred, leaving openings about 3 inches wide. Around this drive 12 piles 10 feet in the bottom and cut them off 2 feet above the top of elbow; place riprap about this to the top of the casting and it is as safe as a more expensive construction.

All intakes and suction pipes for large plants should terminate in a reservoir or pumpwell on shore, to which the water should flow; and while pipes should be so planned that the pumps can operate directly on the intake, yet it is better that the pumpwell or reservoir have screens to shut out all foreign matter and that they be large enough to allow sedimentation to take place. All intake pipes should have valves placed at the outer ends and near the well, with provision for closing both and testing, under pressure through a meter, for leaks, and with air to locate them.

Leaky suctions, whether on shore or under water, are the terror of the engineer at the pumping stotion, reducing the efficiency of the machinery and ruining the engines. A little care and persistency will find and stop the leaky pipes, and save annoyance and coal bills. All suction and intake pipes should, of course, be laid to such a grade that air pockets may be avoided. Where suctions are partly above the water line (as in driven well connections), and are very long, in many cases it has proved advantageous to install an air or vacuum pump to remove the air that comes in from many leaking joints.

I once removed an intake at Negaunee, Mich., laid 10 years before in the bed of a muddy lake, the outer end in 30 feet of water. It was found that in laying the pipe it had broken in five places and for 10 years it had sucked in the disease breeding filth about 100 feet from shore, instead of getting the purer water through the 1,200 feet of pipe as intended. The experience at Duluth, a few years ago, where the intake was discovered broken in several places, and where typhoid was rampant evidently from this cause, is another instance. Neither of these accidents could have happened if provision had been made for testing the main for leaks as advocated above.

A plant taking water from wells across a small pond from their pumping station sunk a line of spiral riveted pipe for a suction and could not lower the wells at all, but an outbreak of typhoid and an investigation and analysis of the water, disclosed the fact that the water in town was identical with that in the filthy pond and entirely unlike the well water. Upon taking up this pipe, a connection was not only found through a tee with a check valve a few feet from shore, but several lengths of the pipe had let go or unwound, and the reason for the sickness and deaths was disclosed.

If the water works managers will look after these underwater force mains, they will find in many cases where a lot of the water they pump goes to; and if they will test their suction pipes going out to good water they will find them sucking in the filth and dangerous poisons in the mud near shore and will find the reason for a good many disease germs found in water taken from the faucets when an analysis of the water at the intake shows nothing of the sort.

Many cases of well supply, ample for domestic service, are supplemented by a dangerous supply to be used only in case of fire, and to be flushed out of the mains afterwards. How does any one know that the filthy water is removed? And how sure are we that a leaky valve or a careless engineman is not all the time mixing our drinks?

## The Beaumont Oil Field.

By Mr. Robert T. Hill.

Before the first white man came, it was known that oil existed in small quantities in western Louisiana and Texas, within 100 miles, more or less, of the present site of Beaumont. It was a matter of rumor for many years that oil floated upon the sea just west of Port Sabine. Petroleum springs existed at several places, notably Lake Charles, Louisiana. It had also been encountered in the well borings in western Louisiana, east of Beaumont. As early as 1862, unprofitable attempts at drilling had been made at Sour Lake. Even at Beaumont similar attempts failed. Until 1901, no man had obtained the oil in commercial quantities.

The finding of oil at Beaumont was not an accident, but, like all other great discoveries, the dramatic culmination of long and extensive research and many experiments, each of which was an important factor in the final result. Capt. A. F. Lucas, to whom the glory of the crowning achievement is fairly due, had been, since 1892, carefully studying the geology of the coastal plain of western Louisiana and eastern Texas, with the view of developing its salt, sulphur and petroleum. With the aid of every recorded observation which he could obtain, supplemented by his own experience and reasoning, he concluded that the structure and stratigraphy of Beaumont gave the best prospect of oil. Previous failures at this place were, in his judgment, due to mechanical difficulties, which could be overcome—an opinion which he fully confirmed by his work.

Capt. Lucas is a native of Austria and a graduate of the Polytechnic School of Gratz and of the Imperial Austrian naval school. He had been for some ten years actively engaged in this country as a mining engineer, especially in the development and operation of the salt mines of Louisiana.

In connection with this work, he found in one or two places indications of oil, and also of sulphur (of the existence of which, in that region, the famous Calcasieu deposit is a proof). Conceiving the plan of a systematic exploration for oil, he finally chose Beaumont, Tex., as the scene of operations. His first well, begun in 1899, was 575 feet deep in March, 1900, and showed a trace of oil at the bottom, when the casing broke, and the well had to be abandoned. Not daunted, he commenced in October, 1900, another well beside the old one. The public will never realize the obstacles and difficulties which had to be overcome. One of Capt. Lucas's greatest technical achievements was the putting of a drill hole through 1,100 feet of clay and quicksand. The methods and contrivances used by him made possible the other wells which have followed. This second well, which "came in" January 19, 1901, was the famous "Lucas Gusher."

*Economic Conditions.*—The Beaumont oil, when first discovered, was found to de of a different quality from that of any other field, and many doubts arose as to its value and uses. Having a heavy base of asphaltum, and being thoroughly impregnated with sulphur, it was supposed to have no value as an illuminant, and many believed that the excess of sulphur would so corrode boilers that it could not be used as a fuel. This sulphur was so apparent that on occasions, as on March 4, 1502, it filled the atmosphere, leaving a coating of sulpher on many of the houses in Beaumont, some 3 miles from the oil field.

The composition of the oil from chemical analyses by Prof. F. C. Thiele is as follows:

| I. | Per cent. |
|---|---|
| Kerosene | 36.00 |
| Light lubricating oil | 21.05 |
| Medium lubricating oil | 21.05 |
| Heavy lubricating oil | 10.52 |
| Asphalt | 6.34 |
| Loss and gases, including sulphur | 5.04 |
| | 100.00 |

Color of crude oil: brown, opaque.
Sp. Grav., 0.9206; equivalent to 22° B. at 65.57° F.

II.

| | |
|---|---|
| Naphtha | 6.45 |
| Kerosene | 35.00 |
| Lubricating oil | 43.90 |
| Residue and gases | 14.65 |
| | 100.00 |

Test of obtained kerosene:

Color. .....Prime white.
Sp. Grav.... 0.872, equivalent to 30° B. at 65.5° F.
Flash point..120° F.
Fire test.....150° F.

It was soon realized that, if fit for no other uses, this was an excellent fuel. After a year of experiment, it is now generally conceded that the oil has many excellent qualities, and that, after refining for the kerosenes, the remainder is as good a fuel and gas making material as can be desired. Upon the basis of elaborate refinery, chemical and fuel tests, made on large quantities, the following facts may be stated as established: (1) The Beaumont oil has a low flash point of 120° F., which renders it an unsafe, or at least undesirable, cargo in tank ships; (2) refined by first distillation, it produces 30 per cent. of export illuminating oil, leaving a residuum of good fuel oil, which can be transported with perfect safety; (3) the sulphur can be extracted if necessary, but when left in the oil has no injurious effect whatever upon the boilers, while it adds to the fuel value; (4) as a fuel, three barrels of this oil can be delivered by rail in any city in Texas, at a price of $2.70, the price of bituminous coal being $5, and that of anthracite coal $10 per ton. The oil may be laid down in New York, Philadelphia or Boston at 75 cents a barrel.

Immediately after the discovery at Spindle Top every acre within 50 miles was leased, and wells were started everywhere. Since it then took from 3 to 6 months to put down one of these costly wells, some time was required to show by experiment that all the oil in the immediate vicinity of Beaumont was confined to Spindle Top hill, within an area of less than 300 acres.[1]

This was at first seriously discouraging. Many thought that if the oil was confined to this one small locality it would soon be exhausted, and the business would be at an end. Prudent operators at Spindle Top did not feel justified in making long-time contracts; and railways and factories, with the risk of an exhausted supply before them, naturally hesitated to make the expensive changes required for the use of this fuel.

The "coming in" of Jennings, Sour Lake and Saratoga removed the fear of inadequate supply; and no one apprehends an early cessation of production, even if Spindle Top should be exhausted, which has not been proved probable.

When the Beaumont well was discovered, the writer, aware that similar conditions existed over a wide area, ventured the following prophecy:

It is entirely within the limit of probability that oil will be found at many places throughout the Coastal Prairie, especially in its southern extension toward the Rio Grande and in the northeastern State of Mexico at Tamaulipas. The outcrop of the Tertiary formations in southwest Texas, in Wilson, Atascosa, McMullen, Duval and other counties, is naturally rich in oil; and the practical oil men are risking their money in experimenting in this region. As the oil bearing Tertiary strata extend east of the Mississippi into Mississippi and Alabama, it is not beyond possibility that oil may be found in these States.

The following data, showing the results of one year's exploitation sufficiently confirm this declaration, which was received at that time with incredulity:

At Jennings, Louisiana, 150 miles east of Beaumont, a good flow of oil has been encountered. This well is 1,830 feet deep, and is described as a mild sort of "gusher." In the morning it spouts about 35 feet, and at other times just high enough to make a good flow. Although this oil is accompanied by a great deal of sand which chokes up the well, it demonstrates the broad geological fact which I asserted. Practical oil men have such faith in the locality that a dozen or more well rigs are at work. The sand problem is a mechanical difficulty which all are confident will be overcome.

Proceeding west from Jennings toward Beaumont, oil has been found in varying quantities at Lake Charles, near Crowley, and in one or two other places.

At Sour Lake, 25 miles northwest of Beaumont, oil has been known to exist since 1862, and a dozen years ago many pumping wells were operated, and a small refinery was established. The field was abandoned, but after the Beaumont discovery numerous well rigs were set up to penetrate to greater depths. From seven to eleven different oil strata were passed through, and in August, 1901, a well, similar to that at Jennings, was obtained by the Guffey people. Its product has not been reported.

On March 7, 1902, another great oil strike was made at Sour Lake, at a depth of 685 feet, by the Atlantic & Pacific Company. It is said that the oil shot 150 feet into the air, and was of better quality than that at Beaumont.

Twelve miles north of Sour Lake, at the village of Saratoga, where the oil outcrops at the surface as maltha, it is said that a good oil well has been obtained, flowing several thousand barrels per day.

Rockland, north of Saratoga, is the next place where oil deposits are found, and experimental boring has been going on here for some time. The sand rock near the surface is completely impregnated with oil.

Between Sour Lake and Houston, 50 miles farther west, many experiments are in progress, but no success has been reported. In the city of Houston, I am informed by Major Cave, of the Houston & Texas Central Railway, that a small flow of oil had come from his well for many years.

Fifty miles south of Houston, near the mouth of the Brazos river, in Brazoria county, there is a field which, according to Capt. Lucas and the geological evidence which we possess, gives excellent indications for oil. There are no less than fourteen expensive well rigs set up in this and Brazoria county, four of which were upon the remarkable hill known as Damon's Mound, one or two at Big Hill, and one at Keyser's Mound.

[To be Continued.]

1. The exact extent of the productive ground of Spindle Top hill has not yet been determined because several of the largest corporations own large tracts on one side of the hill, where the limits have not been exploited. It is known that this field certainly exceeds 300 acres, and most of the oil men think it will reach 330 or 335 acres. It is still occasionally widened by new wells.

## ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. B. C. GUERIN has resigned the superintendency of the Carbondale (Pa.) Gas Company.

THE Municipal Light and Power Company has been incorporated by Messrs. W. C. Sherwood, R. F. Tully and H. A. Bingham. Its initial capital is put at $2,000, and its "home office" is returned as 15 Exchange Place, Jersey City, N. J. Its purpose is to "Buy and construct gas works."

THE Common Council of Niagara Falls, Ont., has granted a franchise to the Niagara Falls (Ont.) branch of the Niagara Falls (N. Y.) Gas and Electric Light Company, under which the latter will at once extend its mains over the Gorge to and through the streets of the former place. Mr. F. A. Dudley, President of the New York branch of the Niagara Falls Company, is to be congratulated on the outcome of his persistence in this matter.

ON the 1st inst., under its agreement with the authorities, the Rochester (N. Y.) Gas and Electric Company reduced its selling rate to $1.10 per 1,000 cubic feet. This rate will prevail until April 1, 1903, when the selling price is to be $1 per 1,000.

AT a special meeting of the shareholders in the Peoples Gas Light Company, Rutland, Vt., it was voted to cancel and discharge an indenture between the Company and the Merchants Trust Company, as Trustee, dated January 1, 1902, given to secure $100,000 of debenture bonds of the Peoples Company, and to cancel all of said bonds. The shareholders then authorized the Peoples Company to issue $100,000 face value of first mortgage, 5 per cent. bonds, to run 50 years, and to cover all of the Company's property whatsoever. The Merchants' Trust Company was named as Trustee.

THE proprietors of the Framingham Gas, Fuel and Power Company, of South Framingham, Mass., have announced an increase in the selling rates, the increase amounting all round to about 5 per cent.

ACCORDING to news from Bayonne, N. J., dated some days ago, odd things are coming to light in connection with the coal famine, and the tragedy of it all is being queerly mixed with bits of humor. Its scarcity and high price have forced the Hudson County (N. J.) Gas Company to take special precautions to prevent the theft of coal from the yards in Bayonne to the gas works in Jersey City. A novel method was evolved to prevent the thieving. As each wagon is filled with coal a layer of

whitewash is applied to the top of the load, which operation naturally made it almost impossible for anyone to take coal from the wagon without the theft being made known. Since this plan has been followed no shortages in supplies shipped by wagons have been reported.

THE Detroit Suburban Gas Company has mortgaged its property in the sum of $250,000 to the Dime Savings Bank Company, of Cleveland, O. The mortgage is to run for 25 years, and is to bear interest at the rate of 5 per cent.

MR. ARTHUR FONTAINE, official Gas and Electric Light Inspector, at St. Hyacinthe, Can., has been transferred to Ottawa as assistant to Mr. Ormond Higman, Chief Electrical Engineer of the Department of Inland Revenue. Mr. Henry Prevost succeeds Mr. Fontaine at St. Hyacinthe.

MR. JOHN A. PATTEN, formerly in charge of the manufacturing and street main systems of the Manitowoc (Wis.) Gas Light Company, has been appointed General Superintendent of the Company. He assumed the duties of his new position the 1st inst.

THE Solvay Process Company has accepted the terms of the franchise passed by the Woodmere (Mich.) Council for the supply of gas to that place.

MR. IRVY MYERS, of North Paterson, N. J., has petitioned the Trustees of Patchogue, L. I., for the right to there construct and operate a gas works. He asks that the franchise shall last for 50 years, and agrees to commence work on the plant immediately on the passage of the grant. He agrees to make the following concessions in consideration of the value of the franchise: As soon as the main pipes are laid in any street whereon there is a church, hospital, public school or other public building he will erect and maintain a street lamp in front of such building and keep the same lighted at all reasonable hours without any cost or expense to the village of Patchogue. That after 1 year from the date of the passage of the ordinance the Company shall pay to the Treasurer of Patchogue, on the 1st day of January in each year, and every year thereafter, 2½ per cent. from the gross sales of gas within said village for the next preceding year.

THE laborers in the employ of the New Brunswick (N. J.) Gas Light Company struck some days ago. The stay-out lasted 20 minutes, the Company at the end of which period had agreed to pay them $1.25 for an 8-hour day.

THE commission appointed to appraise the value of the Norwich (Conn.) Gas Company's properties (which are to be taken over for operation on municipal account) have perfected their organization. Mr. Henry C. White, of New Haven, was chosen President, and the actual sittings to hear testimony will be commenced some time next week.

THE Altoona (Pa.) Gas Company has notified the holders of the bonded issue, dated July 1st, 1903, that under the terms of the mortgage the Company has elected to pay the principal of same on the 22d inst., after which date interests on said bonds shall cease.

MR. W. E. BELLMER has been appointed Superintendent of the Peoples Gas and Electric Company, of Defiance, O.

THE storage holder in process of construction for the City Gas Company, of London, Ont., will have a capacity of 400,000 cubic feet.

MR. C. N. PENNOYER, Manager of the United Gas and Electric Company, of San Jose, Cal., has issued the following sales' schedule, which became effective the 1st inst.: On gas account, $1.60 per 1,000 cubic feet, subject to the following discounts on monthly use: Over 20,000 cubic feet and under 50,000 cubic feet, $1.45 per 1,000 cubic feet; over 20,000 cubic feet and under 30,000 cubic feet, $1.45 per 1,000 cubic feet; over 50,000 cubic feet and under 75,000 cubic feet, $1.40 per 1,000 cubic feet; over 75,000 cubic feet and under 100,000 cubic feet, $1.35 per 1,000 cubic feet; over 100,000 and under 200,000 cubic feet, $1.30; over 200,000 cubic feet, $1.35. For an electric supply: Base rate, 10 cents per 1,000 watt hours. Discounts, monthly consumption: Over 200 k.w. hours, per month and under 400 k.w. hours, 10 per cent; over 400 k.w. hours, and under 600 k.w. hours, 15 per cent.; over 600 k.w. hours, and under 700 k.w. hours, 20 per cent.; over 700 k.w. hours, and under 800 k.w. hours, 25 per cent.; over 800 k.w. hours, and under 1,000 k.w. hours, 30 per cent.; over 1,000 k.w. hours, and under 1,500 k.w. hours, 40 per cent.; over 1,500 k.w. hours, and under 2,000 k w. hours, 45 per cent.; over 2,000 k.w. hours, 50 per cent. discount.

MR. E. N. BOXALL, Secretary of the San Bernardino (Cal.) Gas and Electric Company, has notified the shareholders that a special meeting of the shareholders has been called for the 10th prox. The question then to be decided is whether or not the capital stock shall be increased from $200,000 to $500,000, as per the recommendation of the Board of Directors.

MR. L. L. PALMER has resigned the position of Purchasing Agent and Superintendent to the Waterloo (Ia.) Gas and Electric Company, the resignation to become effective the 1st prox.

THE Logan Natural Gas and Fuel Company has secured a monopoly of the gas supply of Tiffin, O., through its leasing of the properties of the Tiffin Consolidated Gas and Light Company. The lease is to run for 150 years.

THE City Council, of Ensley, Ala., has granted a franchise for the construction and operation of a gas works there to Mr. B. R. Pegram and associates. The latter have agreed to start work on the plant within 60 days of the signing of the grant.

THE properties of the Albion (Mich.) Gas and Coke Company have been purchased by a syndicate, the members thereof being the following: O. B. Kelsey, Cashier of the Peoples Savings Bank, of Albion; H. B. Wales, Secretary and Treasurer of the Grand Rapids Gas Light Company; C. E. Temple, Jno. G. Brown and E. P. Robertson, of Albion; and H. A. Platt, of Chicago. The Company will be reorganized under the name of the Albion Gas Light Company, and a considerable sum will be expended on plant betterment.

THE Hartford City (Conn.) Gas Light Company has purchased what is known as the Beach property, and the Smith plot as well, which acquisitions give it ownership to the square bounded by Front, Potter and Commerce streets and the Park river save the corner plot at Potter and Commerce streets. That section, which is owned by an estate, is to all intent and purpose now controlled by the Company.

THE Superintendent of Construction of the Montreal (Quebec) Gas Company, Mr. C. H. Osler, is quite satisfied over the results of his labors attendant upon the notable changes in the Company's main system that were commenced late last spring. He hopes to have all the changes outlined in the original plan completed before the winter season is upon him.

THE district operated in by the Suburban Gas Company, of Philadelphia, comprises the territory between the Philadelphia city line, 72d street, West Philadelphia, and the Delaware State line, which means a stretch of 12½ miles along the Delaware river. In the territory is the rapidly growing city of Chester, 19 incorporated boroughs and 9 townships.

THE reorganization of the Winston-Salem (N. C.) Gas and Lighting Company is reported. The Directors are: W. M. Reynolds and B. G. McAdoo, of New York; H. T. Dupe and Chas. L. Scott, of Philadelphia, and E. B. Jones and E. H. Wilson, of Salem; President, E. B. Jones; Treasurer, W. M. Reynolds; Secretary, Chas. M. Scott.

MR. THOMAS COOPER has been appointed Superintendent of the Pekin (Ills.) Light, Heat and Power Company, vice H. R. Marcott.

PRESIDENT I. B. TENNEY, of the Deadwood (So. Dak.) Gas Company, the works of which were only a short time ago put in active operation, reports that the business so far done by the Company has exceeded the best estimates thereon made by its promoters and owners.

MESSRS. DEILY & FOWLER, of Philadelphia, will construct a new storage holder for the Doylestown (Pa.) Gas Company. It will be located on the South Main street site.

THE incorporation of the Chemung County Gas Company, of Elmira, N. Y., to supply gas and electricity in Elmira, Elmira Heights, Horseheads and the surrounding territory, is reported. It is capitalized in the sum of $500,000, and the Directors are: D. Blanchard, North Andover, Mass.; A. J. Miller, of New York, and M. H. Arnot, of Elmira.

## The Market for Gas Securities.

The market for city gas shares was in a decidedly muddled condition during the week, and quotations were cut right and left, without any good reason therefor, save the disturbance in money rates, the unfortunate predominating influences in the materials market, and the almost general undertone of mistrust about everything. Consolidated closed to-day (Friday) at 216 to 217, which is considerable of a recovery from the low prices earlier in the week. The Consolidated management have virtually put themselves fairly on the safe side of coal supplies, although the material coming to hand is far from standard quality.

Brooklyn Union experienced a sharp decline. The demand on the Company for gas is putting its engineering staff on their metal, and some of those higher up in authority are now conscious of the fact that it was not wise to have disregarded the recommendations of the engineers as to plant enlargement made about 2 years ago. The closing for Brooklyn Union to day was 225 to 230. Peoples, of Chicago, is steady, and Baltimore Consolidated is in good demand. It is understood that a man well known in New York gas circles is to be named as the Company's General Manager. Washington gas is seemingly being pressed for sale.

## Advertisers' Index.


**GAS ENGINEERS.** Page

Wm. Henry White, New York City ... 535
Fred. Bredel, Milwaukee, Wis. ... 522
Geo. R. Rowland, New York City ... 522
The Western Gas Construction Co., Fort Wayne, Ind. ... 504
Humphreys & Glasgow, New York City ... 533
David Leavitt Hough, New York City ... 532
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 522
Baxter & Young, Detroit, Mich. ... 542
United Gas Improvement Co., Philadelphia, Pa. ... 527
James T. Lynn, Detroit, Mich. ... 532
A. E. Boardman, Brevard, N. C. ... 532
The Jeffrey Manufacturing Co., Columbus, O. ... 530

**GAS WORKS APPARATUS AND CONSTRUCTION.**

Continental Iron Works, Brooklyn, N. Y. ... 534
Deily & Fowler, Philadelphia, Pa. ... 536
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 532
Stacey Mfg. Co., Cincinnati, Ohio. ... 535
Bartlett, Hayward & Co., Baltimore, Md. ... 533
Davis and Farnum Mfg. Co., Waltham, Mass. ... 532
R. D. Wood & Co., Philadelphia, Pa. ... 534
Isbell-Porter Company, New York City. ... 534
Fred. Bredel, Milwaukee, Wis. ... 522
United Gas Improvement Co., Philadelphia, Pa. ... 527
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 522
The Western Gas Construction Co., Fort Wayne, Ind. ... 504
Humphreys & Glasgow, New York City ... 533
Logan Iron Works, Brooklyn, N. Y. ... 536
Riter-Conley Mfg. Co., Pittsburg, Pa. ... 535
Baxter & Young, Detroit, Mich. ... 542
G. Shepard Page's Sons, New York City. ... 532
James T. Lynn, Detroit, Mich. ... 532
A. E. Boardman, Brevard, N. C. ... 532
Christopher Cunningham, Brooklyn, N. Y. ... 529
The Jeffrey Manufacturing Co., Columbus, O. ... 530
Quintard Iron Works, New York City ... 533
The Connersville Blower Company, Connersville, Ind. ... 537
Lloyd Construction Co., Detroit, Mich. ... 532
Connelly Iron Sponge and Governor Co., New York City 457

**PROCESSES.**

Bartlett, Hayward & Co., Baltimore, Md. ... 533
United Gas Improvement Co., Philadelphia, Pa. ... 527
Burdett Loomis, Hartford, Conn. ... 534
Economical Gas Apparatus Construct'n Co, Toronto, Ont. 522
The Western Gas Construction Co., Fort Wayne, Ind. ... 504
Humphreys & Glasgow, New York City. ... 533
B. E. Chollar, St. Louis, Mo. ... 518

**SCRUBBERS AND CONDENSERS.**

R. D. Wood & Co., Philadelphia, Pa. ... 534
Continental Iron Works, Brooklyn, N.Y. ... 534
Logan Iron Works, Brooklyn, N. Y. ... 536
Riter-Conley Mfg. Co., Pittsburg, Pa. ... 535
The Western Gas Construction Co., Fort Wayne, Ind. ... 504

**PRODUCER POWER PLANTS.**

R. D. Wood & Co., Philadelphia, Pa. ... 534

**TAR AND CARBONIC ACID EXTRACTOR.**

The Western Gas Construction Co., Fort Wayne, Ind. ... 504

**AMMONIA CONCENTRATORS.**

Michigan Ammonia Works, Detroit, Mich. ... 518
The Western Gas Construction Co., Fort Wayne, Ind. ... 504

**GAS METERS.**

John J. Griffin & Co., Philadelphia, Pa. ... 540
American Meter Co., New York and Philadelphia ... 539
Helme & McIlhenny, Philadelphia, Pa. ... 539
D. McDonald & Co., Albany, N.Y. ... 537
Nathaniel Tufts Meter Co., Boston, Mass. ... 538
Maryland Meter and Mfg. Co., Baltimore, Md. ... 538
Metric Metal Co., Erie, Pa. ... 539
Keystone Meter Co., Royersford, Pa. ... 538
Detroit Meter Company, Detroit, Mich. ... 508

**PREPAYMENT METERS.**

American Meter Co., New York and Philadelphia ... 539
John J. Griffin & Co., Philadelphia, Pa. ... 540
D. McDonald & Co., Albany, N. Y. ... 537
Helme & McIlhenny, Philadelphia, Pa. ... 539
Nathaniel Tufts Meter Co., Boston, Mass. ... 538
Keystone Meter Co., Royersford, Pa. ... 538

**GAS AND WATER PIPES.**

M. J. Drummond & Co., New York City. ... 524
R. D. Wood & Co., Philadelphia, Pa. ... 524
Warren Foundry and Machine Co., New York City. ... 524
Donaldson Iron Co., Emaus, Pa. ... 524
Christopher Cunningham, Brooklyn, N.Y. ... 529

**GAS MAIN STOPPERS.**

Safety Gas Main Stopper Co., N.Y. City. ... 524

**GAS TAPPING MACHINES.**

George Light, Dayton, O. ... 524
H. Mueller Manufacturing Company, Decatur, Ills. ... 521

**GAS COALS.**

Perkins & Co., New York City. ... 530
Westmoreland Coal Co., Philadelphia, Pa. ... 531
Berwind-White Coal Mining Co., New York and Phila. ... 530

**CANNEL COALS.**

Perkins & Co., New York City. ... 530

**CONVEYORS.**

The Link-Belt Machinery Co., Chicago, Ills. ... 531
The Western Gas Construction Co., Fort Wayne, Ind. ... 504
The Jeffrey Manufacturing Co., Columbus, O. ... 530
C. W. Hunt Company, New York City. ... 521
Akron Cultivator Co., Akron, O. ... 518

**CHARGING BARROWS & COAL WAGONS.**

Akron Cultivator Co., Akron, O. ... 518

**GAS ENRICHERS.**

Standard Oil Co., New York City. ... 531
The Sun Oil Co., Pittsburg, Pa. ... 541

**COKE CRUSHERS.**

C. M. Keller, Columbus, Ind. ... 53
The Jeffrey Manufacturing Co., Columbus, O. ... 530

**STEAM BLOWER FOR BURNING BREEZE.**

H. E. Parson, Brooklyn, N. Y. ... 524
The Connersville Blower Company, Connersville, Ind. ... 537

**ECONOMIZERS.**

Green Fuel Economizer Co., Matteawan, N.Y. ... 529

**GAS GAUGES.**

The Bristol Co., Waterbury, Conn. ... 530

**GAS GOVERNORS.**

Connelly Iron Sponge and Governor Co., New York City 457
Isbell-Porter Co., New York City. ... 534
R. D. Wood & Co., Philadelphia, Pa. ... 534

**CEMENTS.**

C. L. Gerould, Galesburg, Ills. ... 528

**RETORTS AND FIREBRICKS.**

J. H. Gautier & Co., Jersey City, N. J. ... 528
Adam Weber Sons, New York City. ... 528
Laclede Firebrick Mfg. Co., St. Louis, Mo. ... 528
Cyrus Borgner, Philadelphia, Pa. ... 528
James Gardner, Jr., Co., Pittsburg, Pa. ... 528
Henry Maurer & Son, New York City. ... 528
Baltimore Retort and Firebrick Co., Baltimore, Md. ... 523
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. ... 528
Brooklyn Firebrick Works, Brooklyn, N. Y. ... 528
Missouri Firebrick Co., St. Louis, Mo. ... 528

**REGENERATIVE FURNACES.**

Bartlett, Hayward & Co., Baltimore, Md. ... 533
Fred. Bredel, Milwaukee, Wis. ... 522
J. H. Gautier & Co., Jersey City, N.J. ... 528
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. ... 528
Adam Weber Sons, New York City. ... 528
Laclede Firebrick Mfg. Co., St. Louis, Mo. ... 528
Missouri Firebrick Co., St. Louis, Mo. ... 528

**SELF-SEALING MOUTHPIECE DOORS.**

Isbell-Porter Co., New York City. ... 534
Continental Iron Works, Brooklyn, N.Y. ... 534
Logan Iron Works, Brooklyn, N.Y. ... 536
R. D. Wood & Co., Philadelphia, Pa. ... 534
The Western Gas Construction Co., Fort Wayne, Ind. ... 504

**CHIMNEY CONSTRUCTION.**

Adam Weber Sons, New York City. ... 528

**INCANDESCENT GAS LAMPS.**

Welsbach Company, Gloucester, N. J. ... 526
General Gas Light Company, Kalamazoo, Mich. ... 521
D. M. Steward Mfg. Co., Chattanooga, Tenn. ... 520
Detroit Arc Gas Light Co., Detroit, Mich. ... 520
Ball Check Light Co., New York City ... 518 519
Acorn Brass Works Mfg. Co., Chicago, Ills. ... 520

**BURNERS.**

C. A. Gefrorer, Philadelphia, Pa. ... 518
Wm. M. Crane Co., New York City. ... 521
D. M. Steward Mfg. Co., Chattanooga, Tenn. ... 520
Sunlight Lava Mfg. Co., Chattanooga, Tenn. ... 520
Manhattan Brass Co., New York City. ... 518

**LAVA GAS TIPS.**

D. M. Steward Mfg. Co., Chattanooga, Tenn. ... 520
Sunlight Lava Mfg. Co., Chattanooga, Tenn. ... 520

**STREET LAMPS.**

Welsbach Street Lighting Co., New York and Phila. ... 526
Thos. T. W. Miner, New York City. ... 525

**PURIFIERS.**

R. D. Wood & Co., Philadelphia, Pa. ... 534
Stacey Mfg. Co., Cincinnati, O. ... 531
The Western Gas Construction Co., Fort Wayne, Ind. ... 504

**PURIFYING MATERIALS.**

Connelly Iron Sponge and Governor Co., New York City 457

**VALVES.**

Ludlow Valve Manufacturing Co., Troy, N.Y. ... 521
R. D. Wood & Co., Philadelphia, Pa. ... 534
Continental Iron Works, Brooklyn, N. Y. ... 534
The P. H. & F. M. Roots Co., Connersville, Ind. ... 523
Isbell-Porter Co., New York City. ... 534
The Western Gas Construction Co., Fort Wayne, Ind. ... 504
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 532

**EXHAUSTERS.**

The P. H. & F. M. Roots Co., Connersville, Ind. ... 523
Isbell-Porter Company, New York City. ... 534
Connelly Iron Sponge and Governor Co., New York City 457
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 532
The Connersville Blower Company, Connersville, Ind. ... 537

**ELECTRICAL APPARATUS.**

Wm. Henry White, New York City. ... 535

**BOILERS, STACKS, TANKS, ETC.**

The Hazelton Boiler Company, Rutherford, N.J. ... 530

**PURIFIER SCREENS.**

John Cabot, New York City. ... 530

**GAS STOVES.**

American Meter Co., New York and Philadelphia. ... 525
Maryland Meter and Manufacturing Co., Baltimore, Md 538
Keystone Meter Co., Royersford, Pa. ... 538
Nathaniel Tufts Meter Co., Boston Mass. ... 538

**HOT WATER HEATERS.**

The Humphrey Mfg. and Plating Co., Kalamazoo, Mich. 524

**GASHOLDER TANKS.**

J. P. Whittier, Brooklyn, N.Y. ... 522

**GASHOLDERS.**

Bartlett, Hayward & Co., Baltimore, Md. ... 535
Continental Iron Works, Brooklyn, N.Y. ... 534
Deily & Fowler, Philadelphia, Pa. ... 536
Davis & Farnum Mfg. Co., Waltham, Mass. ... 532
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 532
Stacey Mfg. Co., Cincinnati, O. ... 535
R. D. Wood & Co., Philadelphia, Pa. ... 534
Logan Iron Works, Brooklyn, N.Y. ... 536
Riter-Conley Mfg. Co., Pittsburg, Pa. ... 535

**STORAGE TANKS.**

Christopher Cunningham, Brooklyn, N.Y. ... 529

**INVESTORS.**

W. R. Faben Construction Company, Toledo, O. ... 518



## DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., N. W. CORNER BROAD AND ARCH STS., PHILADELPHIA, PA., Sept. 10, 1902.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Oct. 15th, 1902, to stockholders of record at the close of business, Sept. 30, 1902. Checks willbe mailed.

1423-5 LEWIS LILLIE, Treasurer

## Gas Analyses of All Sorts and Conditions,

—OR—

**Analyses of Solid and Liquid Materials as Well,**

That are needed by Gas Companies at any time in the conduct of their business, may be obtained from

DR. W. H. BIRCHMORE,

1421-tf 341 ADELPHI ST., BROOKLYN, N. Y.

## Position Wanted.

A YOUNG MAN, 28 years of age, sterling habits, gilt-edge references, 11 years in the gas and electric business, at present Manager in town of 10,000, desires position as Secretary or Manager of gas or electric plants in city of not less than 20,000.

1425-4 Address, "L.," care this Journal.

## WANTED,

A Good Retort House Foreman.

1424-tf Address, "GAS COMPANY," care this Journal.

## WANTED,

**Second-hand Station Meter,** from 60 to 72 inches diameter.

**Four Purifying Boxes,** 9 feet by 12 feet, or about that capacity.

1416-tf Address, G. M. ROSSMAN, Treas., Keene, N. H.

## Purifiers for Sale.

At a bargain. Four boxes, 10 feet by 12 feet by 3½ feet; nearly new. Ten-inch connections and dry centerseal. Write for price and particulars to

PITTSFIELD COAL GAS COMPAFY,
1425-tf Pittsfield, Mass.

Utilize Your Gas Liquor.
NO EXTRA LABOR OR OPERATING EXPENSES.

**Ammonia Concentrator.**

Not Expensive. Write to STROH & OSIUS, Pat'ees, or Mich. Ammonia Works, Detroit, Mich.

## GAS BURNERS,

To burn a given amount at a stated pressure, made to order. Samples furnished. Also, small oil and air valves, slow-feed valves for high pressure, and small brasswork in general.

Drip Pumps, Service Cleaners, Gasfitters' Proving Pumps and Mercury Gauges.

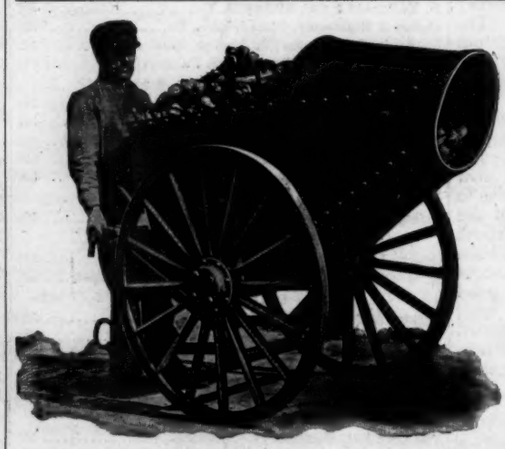
C. GEFRORER & SON,
248 North 8th Street, Philadelphia, Pa.

## IN THE MARKET.

WE PURCHASE:

**Gas properties,**
**Electric light properties.**
**Street railway properties.**
**Also desirable franchises.**

W. R. FABEN CONSTRUCTION CO.,
1383-tf 317 St. Claire Street, Toledo, O.



**Charging Barrows,**
**Coal and**
**Coke Wagons,**
**Steel Wheelbarrows.**

All Specially Adapted for Use in Gas Works.

THE AKRON CULTIVATOR CO.,
MANUFACTURERS,
**Akron, O.**

## Chollar's System of Gas Purification.

THE PURIFIED GAS REVIVES THE FOULED OXIDE.

MEMBERS of the American Gas Light Association and their friends are cordially invited to visit the exhibition rooms of the BALL CHECK LIGHT COMPANY, and inspect the Ball Check System, in lamps from twenty-five candle power up to twelve hundred.

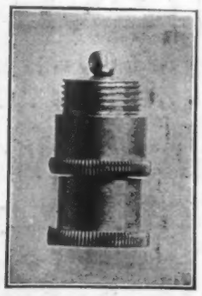
Our offices, telephones and messenger service are at their disposal day and night.

ALL THE ELEVATED, BROADWAY AND AVENUE CARS LEAD TO PARK PLACE.

# Ball Check Light Co.,

16 & 18 PARK PLACE, NEW YORK CITY.

# See that Ball? ☛



JUST A TWIST OF THE WRIST

AND YOUR LIGHT IS BRIGHT.

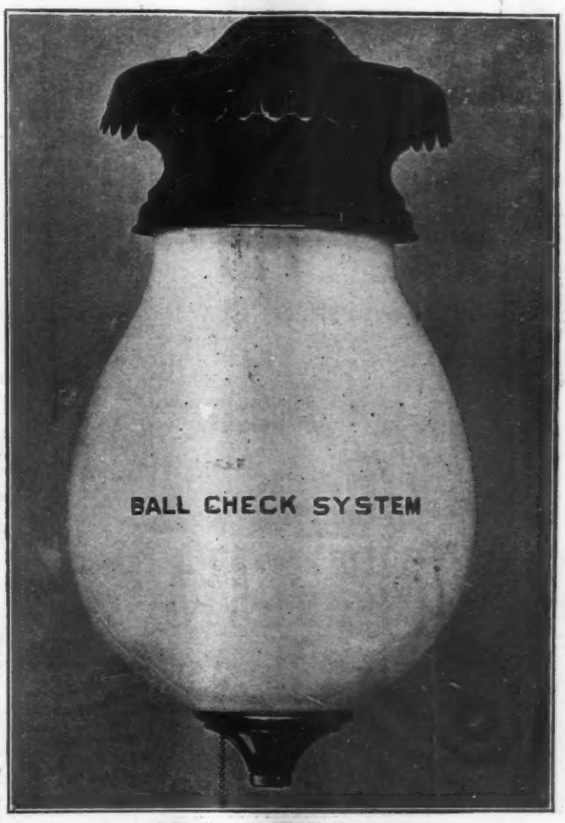
ANY CANDLE POWER. CAN'T CLOG.

## That's the Ball Check System.

**MORE LIGHT, LESS GAS.**

That's "The Story."

# GAS ARC LAMPS.




**Highest Efficiency.**

ANY GAS—ANY PRESSURE—INSTANT ADJUSTMENT.

"THE BALL DOES IT ALL."

## Why?

Because the Ball Check spreads and breaks up the gas, also checks the flow, but maintains the initial pressure of gas. The common mantle burners with the Ball Check light up to the top full mantles of any length up to six inches. **No more long mixing tubes.** The **Ball Check** takes one just **one and one-half inches long.**

## Want to try one?

We will send by mail, postage paid, to any gas company or dealer, a sample Ball Check, upon receipt of a dime--they retail for a quarter--that will fit an ordinary cheap mantle burner. It tells its own story in just a minute.

# Ball Check Light Company,

# 16 & 18 Park Place, New York.

# STEWARD BURNERS.

6 SIZES.
5 PRESSURES.

Made with a check to consume rated amounts accurately.

SIZES, - 1½, 2, 3, 4, 5, 6 feet. - - - PRESSURES, - 8/10, 12/10, 15/10, 20/10, 25/10.

THE D. M. STEWARD MFG. CO., {ESTABLISHED 1876.

NEW YORK: 107 Chambers Street. CHICAGO: 57 Washington Street. FACTORY AND GENERAL OFFICE: Chattanooga, Tenn. 1

# 144

Perfect Tips to each gross bear the name :: ::

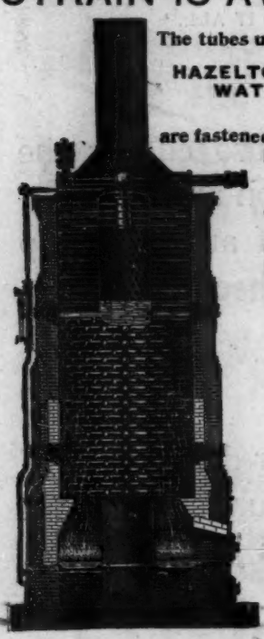
SUNLIGHT.

SAMPLES FREE.
SMALL ORDERS SOLICITED.
PROMPT SHIPMENTS.

# SUNLIGHT LAVA MFG. CO.,

## CHATTANOOGA, TENN.

## STRAIN IS AVOIDED.



The tubes used in

HAZELTON WATER TUBE BOILERS

are fastened at one end only It is easy to see why the expansion and contraction of the tubes cannot affect any other part of the boiler And this is only one of many exclusive features of

HAZELTON Water Tube Boilers

Our Booklet for the Asking.

THE Hazelton Boiler Co.,

Main Office and Works Rutherford, N. J., U.S.A.

Tele., 6M Rutherford

Cable Address: "Pails," Rutherford

THE

# Lumo Triple Arc.

THE cut herein shown is the only explanation necessary. The beauty of the fixture, together with the brilliancy and cheapness of operation, is what does the talking. The Triple Arc is equal in candle power to any gas arc lamp upon the market, and will only consume from 9½ to 10 feet of gas per hour.

The construction of the fixture is simplicity itself, and there is absolutely nothing to get out of order. In fact, we guarantee it to be satisfactory in every particular. We will send a sample lamp on 30 days' trial to any gas company. Any infringement of these designs will be prosecuted.

## ACORN BRASS WORKS MFG. CO.,

55 N. Green St., Chicago, Ills.

# The DETROIT

*Force Draft*

## ARC GAS LAMP.

Durability,
Efficiency,
Simplicity,
Economy.

***Perfect Combustion.***
***No Chimneys to Break.***
***No Matches Necessary.***
***Consumes Less Gas.***
***A Handsome Fixture***
***Always in Order.***

Our lamp gives 25 per cent. ***more light*** with 20 per cent. ***less gas*** than any Arc Gas Lamp now on the market.

TO LIGHT CONSUMPTION WHAT THE GAS RANGE IS TO FUEL. : : : : :

SAMPLE ORDERS *Solicited.*

Manufactured by

The Detroit Arc Gas Light Co.,

67 to 71 Michigan Avenue,

DETROIT, MICH.

# Coal Tar Genealogical Tree.

Mr. T. Viner Clarke, of London, Eng., having compiled a novel Chart or Map illustrating the various CHEMICAL PRODUCTS DERIVED FROM COAL AND COAL TAR, in the form of a Genealogical Tree, including all the products discovered (the total number amounting to near 700), offers for sale a limited number of copies in Colors, mounted on Linen, with Rollers. Price, $3.50. Orders may be sent to

## A. M. CALLENDER & CO., No. 42 Pine Street, New York.

# BRAY BURNERS

Of Uniform Excellence and Greatest Candle Power.

**WILLIAM M. CRANE CO.,**

1131-1133 Broadway, New York,

SOLE AGENTS FOR UNITED STATES.

# "THE MINER"

Globe

Street and Boulevard

**Lamps.**

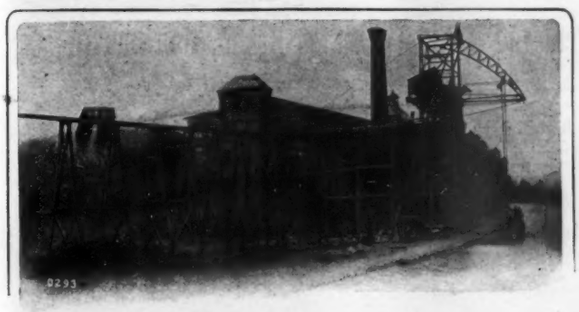
**Cheapest and Best.**

THOUSANDS IN USE WITH INCANDESCENT BURNERS.

*Send for Catalogues.*

**THOMAS T. W. MINER,**

821-823 Eagle Av., N.Y.



No. 0293. Hunt Automatic Railway.

## THE HUNT AUTOMATIC RAILWAY

**furnishes the quickest and cheapest method of transporting coal from boat or car to storage yard.**

**The expense of moving the coal or other materials is reduced to the wages of one man.**

**For particulars, address**

**C. W. HUNT COMPANY,** WEST NEW BRIGHTON, STATEN ISLAND, N. Y. Pittsburg Offices, 515 Penn Avenue.

THIS IS THE

# HUMPHREY GAS ARC LIGHT,

**The Best Light in the World**

**FOR LIGHTING**

**Stores, Churches, Halls or any large indoor areas.**

**Guaranteed to give a greater volume of light, better diffused and steadier than an electric arc.**

**A Complete Revolution in Gas Lighting.**

**A sample lamp sent on 30 days' trial to any Gas Company.**

**This lamp is thoroughly protected with both Mechanical and Design Patents. Imitation of this Design and Construction will be prosecuted.**

**Manufactured by the**

**General Gas Light Co.,**

KALAMAZOO, MICH.

# MUELLER TAPPING MACHINES.

B-100.

WHICH is the greater thief, the man who steals from you but once in a lifetime, or the leaking tap in the gas main that robs you the year round?

**Mueller Gas Main Tapping Machines** have tools that make correct threads, and their use will soon dispense with the annoyance of leaking taps.

Catalogue 3-B describes five machines, with range of tap from $\frac{3}{8}$ inches to 3 inches.

MADE ONLY BY **H. MUELLER MFG. CO.,** DECATUR, ILLS., U. S. A.

THE

# Ludlow Valve Mfg. Co.,

**TROY, N. Y., U. S. A.**

**Double and Single Gate Valves, ¼" to 72",**

—FOR—

**Gas, Water, Steam, Oil, Ammonia, Etc.**

**HOT GAS VALVES A SPECIALTY.**

**Send for Catalogue.**

# FRED. BREDEL, C.E.

## Coal and Water Gas Plants.

**OWN SYSTEM.**

RECUPERATIVE FURNACES, WASHERS, CONDENSERS, PURIFIERS, PURIFYING MACHINES, COKE CONVEYERS, ETC.

SOLE UNITED STATES AGENT FOR

ARROL-FOULIS MECHANICAL CHARGING AND DRAWING MACHINES.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

**GAS RETORTS AND SPECIAL BLOCKS AND FIREBRICK MANUFACTURED UNDER THE SUPERINTENDENCE OF MY OWN CHEMIST.**

COMPLETE GAS WORKS

**No. 118 Farwell Avenue, · Milwaukee, Wis.**

# Lloyd Construction Company,

GREENWOOD AVE. AND M. C. R. R.,

## DETROIT, MICH.

MANUFACTURERS AND CONSTRUCTORS OF GAS APPARATUS AND PLANTS.

# AMMONIA IMMERSION WASHERS.

A new design in which the gas passes under perforated plates and is washed in the suspended water and spray. Built in sections, each section complete. The entire interior accessible for cleaning from the outside.

## THE ECONOMICAL GAS APPARATUS CONSTRUCTION COMPANY, LIMITED,

Engineers and Builders of water and coal gas apparatuses and general gas works machinery. : : :

**AMERICAN OFFICES:**
269 Front Street, East Toronto, Ont.

**LONDON OFFICES:**
19 Abingdon St., Westminster, S. W.

**CABLE ADDRESS:**
"CARBURETED" LONDON AND TORONTO.

## GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE

Plans prepared and Estimates furnished at short notice.
**J. P. WHITTIER,**
238 Java Street, Brooklyn, N. Y.

## GEORGE R. ROWLAND,

Formerly with the Continental Iron Works.
**Draughtsman and Constructing Engineer.**
Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.
Office, No. 245 Broadway, N. Y. City

The Advertisement of the

CONNELLY IRON SPONGE AND GOVERNOR COMPANY,

395 Broadway, New York City,

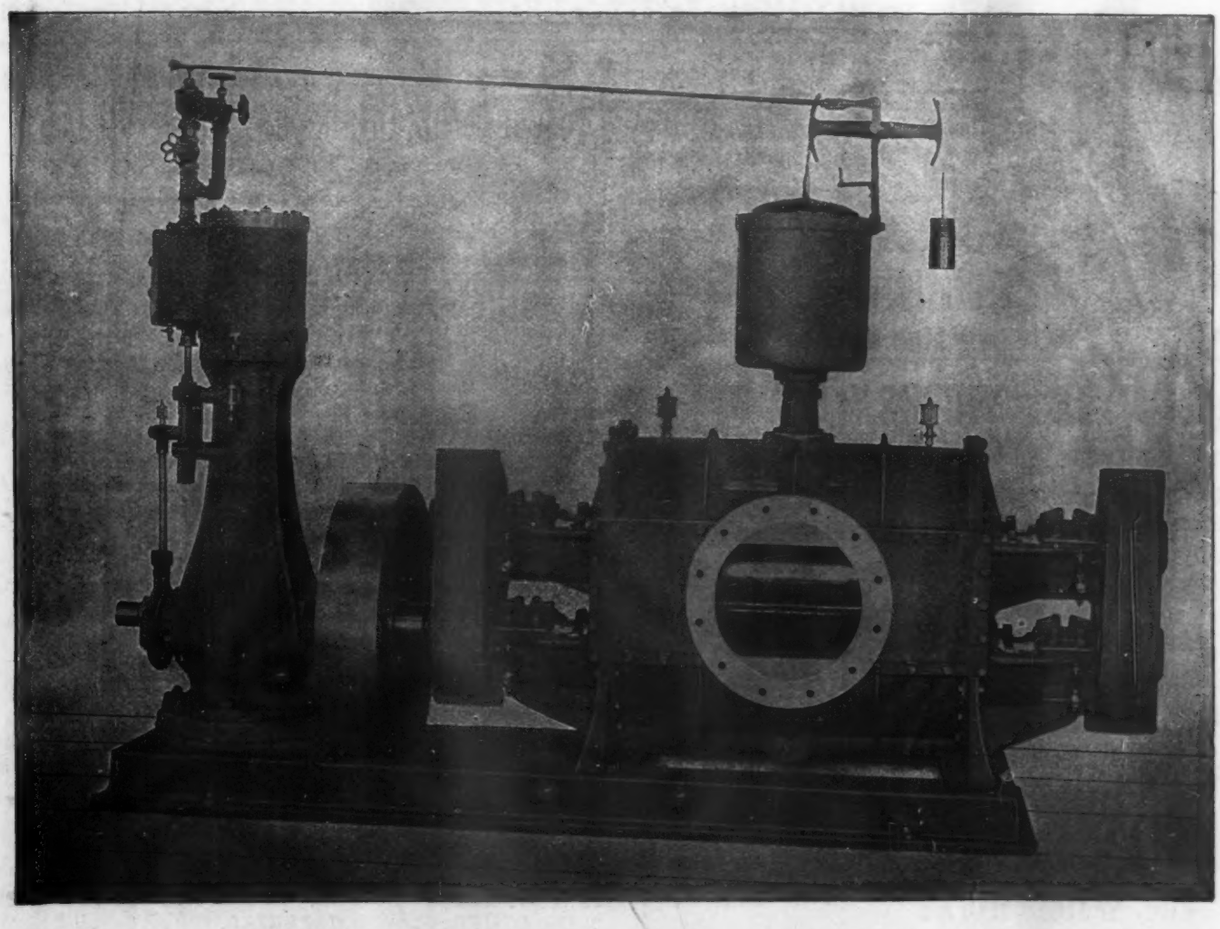
Occupies this Space Every Alternate Week.

ROOTS'

# NEW GAS EXHAUSTER.

Always in the lead. Always anticipating the requirements of the trade. Our new Exhauster meets all demands of modern gas making and overcomes all difficulties heretofore experienced.

OUR GAS GOVERNOR IS MAKING FRIENDS EVERY DAY.



P. H. & F. M. ROOTS CO.,

Connersville, Ind. 109 Liberty St., New York.

Eastern Office:

CONNELLY IRON SPONGE AND GOVERNOR CO., 395 BROADWAY, NEW YORK CITY.

M. J. DRUMMOND & CO.
MANUFACTURERS OF
CAST IRON FLANGE GAS AND WATER PIPE
GENERAL SALES OFFICE, 192 BROADWAY, NEW YORK.

GEORGE ORMROD, Manst. & Treas., Emaus, Pa.
JOHN DONALDSON, Prest., Betz Bldg., Phila., Pa.
EMAUS PIPE FOUNDRY.
DONALDSON IRON COMPANY. EMAUS, PA.
MANUFACTURERS OF
CAST IRON PIPE AND SPECIAL CASTINGS
FOR WATER AND GAS.
Also, FLANGE PIPE, LAMP POSTS, Etc.

GAS TAPPING MACHINES
—FOR—
Drilling and Tapping Pipe under Pressure
WITHOUT ANY ESCAPE OF GAS.
They are Strong and Compact.
Size of Combination Drills and Taps ¾ to 4-inch.
*Machines Sent to any Gas Company for Thirty Days' Trial.*
Send for Circulars.
Geo. Light,
DAYTON, O.

Hughes' "GAS WORKS,"
Their Construction and Arrangement,
And the Manufacture and Distribution of Coal Gas.
Originally written by SAM'L HUGHES, C.E.
Rewritten and Much Enlarged by
WM. RICHARDS, C.E.
Eighth Edition, Revised, with Notices of Recent Improvements.
Price, $1.65.
A. M. CALLENDER & CO., 42 PINE ST., N. Y. CITY.

THE
Valuation of Gas, Electricity and Water Works
FOR ASSESSMENT PURPOSES.
SECOND EDITION.
THOS. NEWBIGGING, M.Inst.C.E., and WM. NEWBIGGING, Assoc.M.Inst.C.E.
With an Appendix of Decided Cases.
Price $2. For Sale by
A. M. CALLENDER & CO.,
42 Pine Street, N. Y. City.

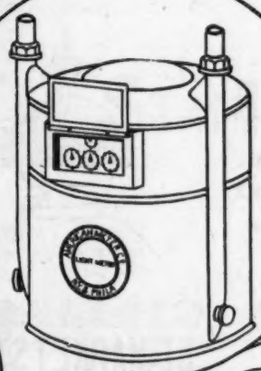
WARREN FOUNDRY AND MACHINE CO.,
Established 1856. Works at Phillipsburgh, N. J.
New York Office, 160 Broadway.
CAST IRON WATER AND GAS PIPE,
FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF
Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

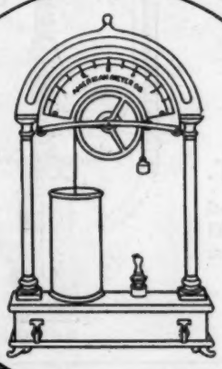
SAFETY GAS MAIN STOPPER COMPANY,
For Shutting Off Gas in Mains
Temporarily during alterations and repairs. : : : :
Any size gas main can be shut off in 30 seconds. : : :
GOODMAN STOPPER
STOPPERS SENT ON TRIAL.
Address: SAFETY GAS MAIN STOPPER CO., 108 E. 117th St., New York City.

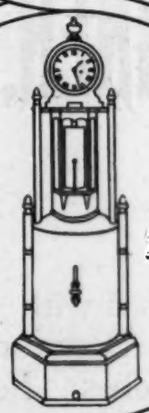
MOST GAS COMPANIES DO SELL, EVERY GAS COMPANY SHOULD SELL
Humphrey Crescent Instantaneous Water Heaters,
A LUXURY and NECESSITY.
This is Our No. 2 Heater.
Supplies hot water for domestic use as well as for the bath. It Has No Equal
LIST PRICE NICKEL PLATED, $35.00,
including nickel plated shelf and brackets.
We have many styles, which range in price from our No. 10, at $45.00, to our No. 8, at only $20.00.
Every Heater Guaranteed.
SEND FOR CATALOGUE AND PRICES.
Will send heater on 60 days' trial to any Gas Company.
The Humphrey Manufacturing and Plating Company, KALAMAZOO, MICH., U. S. A.

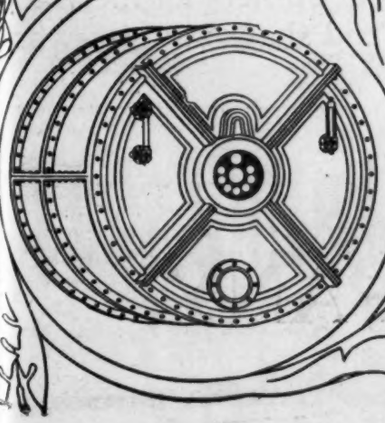
Parson's Steam Blower
FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.
PARSON'S TAR BURNER,
FOR USING COAL TAR AS FUEL.
PARSON'S AIR JET TUBE CLEANER,
FOR CLEANING BOILER TUBES.
These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY.
H. E. PARSON, Supt., 457 Putnam Ave., Brooklyn, N. Y.

(Copyrighted, 1894, by the AMERICAN METER CO.)









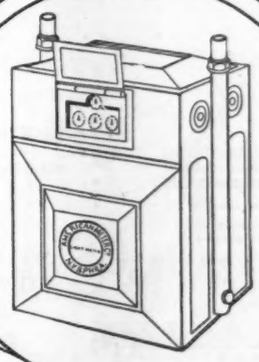
# AMERICAN METER CO.

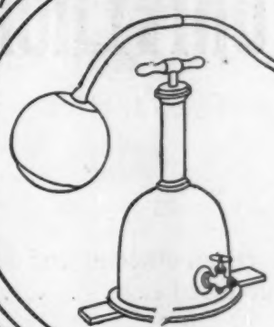
ESTABLISHED 1834. INCORPORATED 1863.

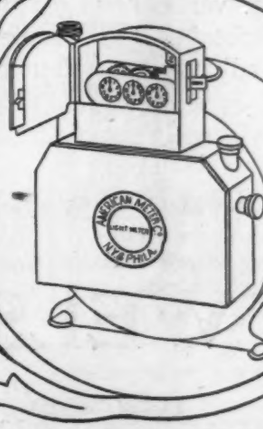
**NEW YORK AND PHILADELPHIA,**

**CHICAGO, ST. LOUIS,**

**SAN FRANCISCO.**







## PUBLIC LIGHTING TABLE.

### NOVEMBER, 1902.

| Day of Week. | Date. | Table No. 1. Following the Moon. Light. | Extinguish. | Table No. 2. New York City. All Night Lighting. Light. | Extinguish. |
|---|---|---|---|---|---|
| | | | | P.M. | A.M. |
| Sat. | 1 | 5.30 PM | 5.30 AM | 4.45 | 5.35 |
| Sun. | 2 | 5.30 | 5.30 | 4.45 | 5.35 |
| Mon. | 3 | 5.30 | 5.30 | 4.45 | 5.35 |
| Tue. | 4 | 7.20 | 5.30 | 4.45 | 5.35 |
| Wed. | 5 | 8.10 | 5.30 | 4.40 | 5.45 |
| Thu. | 6 | 9.00 | 5.30 | 4.40 | 5.45 |
| Fri. | 7 | 10.00 | 5.30 | 4.40 | 5.45 |
| Sat. | 8 | 11.00 FQ | 5.30 | 4.40 | 5.45 |
| Sun. | 9 | 12.00 | 5.40 | 4.40 | 5.45 |
| Mon. | 10 | 1.00 AM | 5.40 | 4.40 | 5.45 |
| Tue. | 11 | 2.00 | 5.40 | 4.40 | 5.45 |
| Wed. | 12 | 3.10 | 5.40 | 4.30 | 6.00 |
| Thu. | 13 | 4.20 | 5.40 | 4.30 | 6.00 |
| Fri. | 14 | No L. | No L. | 4.30 | 6.00 |
| Sat. | 15 | No L. FM | No L. | 4.30 | 6.00 |
| Sun. | 16 | No L. | No L. | 4.30 | 6.00 |
| Mon. | 17 | 5.10 PM | 7.50 PM | 4.30 | 6.00 |
| Tue. | 18 | 5.10 | 9.00 | 4.30 | 6.00 |
| Wed. | 19 | 5.10 | 10.10 | 4.25 | 6.00 |
| Thu. | 20 | 5.10 | 11.10 | 4.25 | 6.00 |
| Fri. | 21 | 5.10 LQ | 12.20 AM | 4.25 | 6.00 |
| Sat. | 22 | 5.10 | 1.30 | 4.25 | 6.00 |
| Sun. | 23 | 5.10 | 2.30 | 4.25 | 6.00 |
| Mon. | 24 | 5.10 | 3.30 | 4.25 | 6.00 |
| Tue. | 25 | 5.10 | 4.30 | 4.25 | 6.00 |
| Wed. | 26 | 5.10 | 6.00 | 4.20 | 6.10 |
| Thu. | 27 | 5.10 | 6.00 | 4.20 | 6.10 |
| Fri. | 28 | 5.10 | 6.00 | 4.20 | 6.10 |
| Sat. | 29 | 5.10 NM | 6.00 | 4.20 | 6.10 |
| Sun. | 30 | 5.00 | 6.00 | 4.20 | 6.10 |

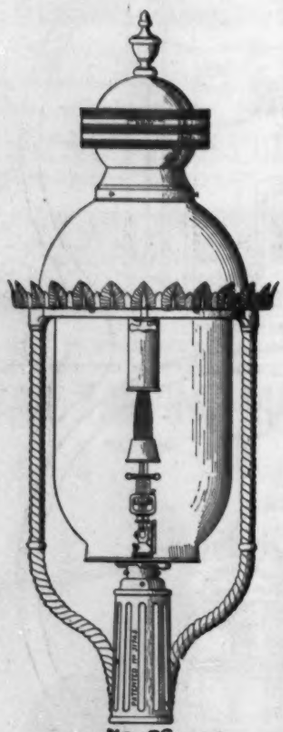
### TOTAL HOURS LIGHTING DURING 1902.

| By Table No. 1. | Hrs.Min. | By Table No. 2. | Hrs.Min. |
|---|---|---|---|
| January | 238.30 | January | 423.20 |
| February | 196.20 | February | 355.25 |
| March | 196.20 | March | 355.35 |
| April | 166.40 | April | 298.50 |
| May | 151.40 | May | 264.50 |
| June | 131.10 | June | 234.25 |
| July | 142.40 | July | 243.45 |
| August | 162.00 | August | 280.25 |
| September | 179.00 | September | 321.15 |
| October | 216.30 | October | 374.30 |
| November | 224.10 | November | 401.40 |
| December | 250.00 | December | 433.45 |
| Total, yr. | 2255.00 | Total, yr. | 3987.45 |

NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

# WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



No. 36.

Controls and Operates the

## Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others Interested in Municipal and Outside Lighting.

No. 38.

# UNIVERSAL WELSBACH BURNER.

The most practical, efficient and artistic burner yet produced. . . . . .

It contains an improved adjustable Bunsen so constructed as to permit of a wide range of variations in gas pressure without blackening the mantles and without an adjustable air shutter. . .

It can be used with all styles and sizes of glassware, either shades or globes. No further necessity to carry a stock of different burners for the many sizes and shapes of glassware.

GAS COMPANIES AND DEALERS CANNOT FAIL TO APPRECIATE THE MANY SALABLE FEATURES OF THIS NEW BURNER.

# WELSBACH COMPANY,

GLOUCESTER, N. J. CHICAGO, ILLS.

Salesrooms in all the Leading Cities of the United States.

# THE STANDARD DOUBLE SUPERHEATER

## LOWE WATER GAS APPARATUS.

The capacity of apparatus installed, if operated continuously, is sufficient to make more than the entire amount of artificial gas annually sold in the United States.

# The United Gas Improvement Company,

**Broad and Arch Streets, Philadelphia.**

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

**J. H. Gautier & Co.**

Greene & Essex Streets,
Jersey City, N. J.

MANUFACTURERS OF

CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

A. H. GUTKES, President. E. L. RICE, Vice-President. H. A. PERKINS, Secretary.

**Brooklyn Fire Brick Works,**

MANUFACTURERS OF

CLAY RETORTS, FIRE BRICK,
Gas House and other Tile.

Office, 88 Van Dyke St., Brooklyn, N. Y.

Established 1854. Incorporated 1869.

**LACLEDE**
**Fire Brick Manufg. Co.,**

Manufacturers of { GAS RETORTS . .
FIRE BRICK . . .
RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Proprietors for the U. S., Coze System of Inclined Benches.

*Estimates Furnished on Application for Most Successful Style of Construction.*

Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

Office: 914, 915 & 916 Wainwright Building, St. Louis, Mo.

**ELECTRIC GAS LIGHTING.**

HOW TO INSTALL ELECTRIC GAS IGNITING APPARATUS, INCLUDING THE JUMP SPARK AND MULTIPLE SYSTEMS FOR USE IN HOUSES, CHURCHES, THEATERS, HALLS, SCHOOLS, STORES OR ANY LARGE BUILDING. ALSO, THE CARE AND SELECTION OF SUITABLE BATTERIES, WIRING AND REPAIRS.

By H. S. NORRIE.

Price, 50 cents. Orders may be sent to

A. M. CALLENDER & CO., 42 PINE ST., N. Y. CITY.

**Adam Weber Sons.**

Manhattan Fire Brick and Enameled Clay Retort Works.

Works, Weber, N. J.

Main Offices Park Row Bldg., New York.

Modern Recuperative Furnaces.

Standard Fire Brick and Gas Retorts.

Designers and Builders of Chimneys of Perforated ..Radial Blocks..

ISAAC C. BAXTER, President.

Works, LOCKPORT STATION, PA.

—ESTABLISHED 1864.—

**JAMES GARDNER, JR., CO.,**

Successor to WILLIAM GARDNER & SON,

PETER YOUNG, Sec'y and Treas.

Address all communications to JAMES GARDNER, JR., CO., Box 277, JOHNSTOWN, PA.

**Fire Clay Goods for Gas Works.**

**HENRY MAURER & SON,**

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

**RETORT WORKS**

WORKS, Perth Amboy, N. J.

OFFICE, 418 to 422 East 23d St., N. Y.

**Clay Gas Retorts,**

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

**GEROULD'S IMPROVED RETORT CEMENT**

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

*Price List, f.o.b. Galesburg, Ills., or Buffalo, N. Y.*

In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD, Galesburg, Ills.

For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

**Parker-Russell Mining and Mfg. Co.,**

CITY OFFICE,
417 Pine Street, St. Louis, Mo.

PROPRIETORS OF THE

OAKHILL GAS RETORT & FIRE BRICK W'KS

Our immense establishment is now employed almost entirely in the manufacture of

**Materials for Gas Companies**

We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct

Half and Full Depth Benches of Our Own Design,

Containing 6, 8 or 9 Retorts.

We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

THEO. J. SMITH, Prest. J. A. TAYLOR, Sec.
A. LAMBLA, Vice-Prest. and Supt.

**BALTIMORE RETORT & FIRE BRICK CO.**

MANUFACTORY AT

LOCUST POINT, BALTIMORE, MD.

**Clay Retorts, Blocks & Tiles**

FIRE BRICK, FIRE CLAY, AND FIRE CEMENT.

Our Improved Half and Full Depth Benches have been Adopted by Many Gas Companies.

WALDO BROS., 102 MILK ST., BOSTON, MASS.

Sole Agents for New England States.

JOHN DELL,
*President and General Manager.*

**MISSOURI FIRE BRICK CO.,**

ESTABLISHED 1882.

—MANUFACTURERS OF—

**Gas Retorts, Bench Settings, Fire Brick, Cupola Linings, Etc.**

*We are the* **Exclusive Agents** *for the* **Mitchell Patent Benches,** *Constructed with Half or Full Depth Furnaces, to Burn either Coal or Coke, and Arranged for Front or* **Rear Clinkering.** *The* **Mitchell** *is the* **Original Coal Firing Bench.** *We also Erect Plain Benches with* **One** *to* **Six Retorts.**

YOUR CORRESPONDENCE IS RESPECTFULLY SOLICITED.

City Office: *411 Olive Street, Continental Bank,* ST. LOUIS, MO.

# CHRISTOPHER CUNNINGHAM,

PROPRIETOR,

# THE NOVELTY STEAM BOILER WORKS,

## BROOKLYN, N. Y.

## STORAGE TANKS FOR GAS WORKS,

To Retain Fluid Material of Any Sort.

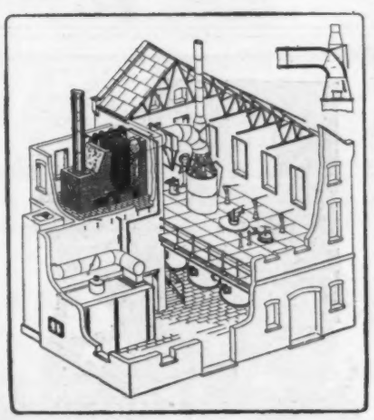
## PIPING IN AND AROUND GAS WORKS.

Work Done for Several of the Largest Gas Companies in America Stands as Reference.

## Economize Heat in Water Gas Plants,

BY UTILIZING A

## Green's Economizer,



**To absorb the heat now going to waste when you blow through your superheater to heat the feed water for your boilers to the temperature of the steam. This is now being done at the Poughkeepsie Gas Works, Poughkeepsie, N. Y. : : : : :**

Write for full particulars how this is accomplished, the saving effected, and the advantages gained, to the

**GREEN FUEL ECONOMIZER CO.,**

MATTEAWAN, N. Y.

PRACTICAL HANDBOOK ON

# GAS ENGINES,

With Instructions for Care and Working of the Same.

**By G. LIECKFELD, C.E.**

**Translated with Permission of the Author, by GEO. M. RICHMOND, M.E.**

PRICE, $1.00.

**A. M. CALLENDER & CO., 42 Pine Street, New York City.**

JAMES D. PERKINS, President. F. SEAVERNS, Treasurer.

# THE PERKINS COMPANY,

228 and 229 Produce Exchange, New York City.

TIDEWATER SALES AGENTS FOR THE FOLLOWING:

## Ocean Mine Youghiogheny Gas Coal,
## Old Kentucky Shale and O. K. Boghead.

SHIPMENTS FROM NEW YORK, PHILADELPHIA, BALTIMORE AND NORFOLK.

## BERWIND-WHITE COAL MINING COMPANY'S

## Ocean Westmoreland Gas Coal.

**Offices:**
Washington Building, New York.
Betz Building, Philadelphia.

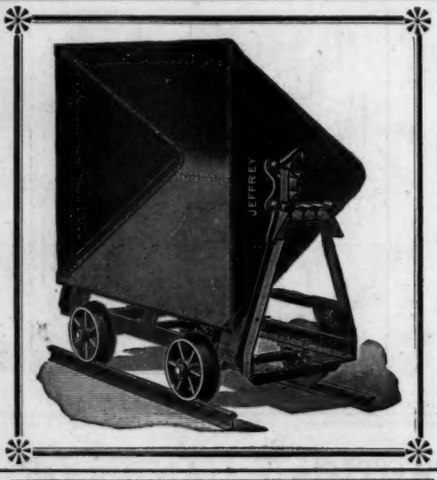
**STRICTLY** High Grade. . . . .
Carefully Prepared.
For Gas Making or
Heavy Steaming. .

**A. C. M. AZOY, General Agent, 1 Broadway, New York.**

ELEVATING MACHINERY.

SEND FOR OUR CATALOGUE AND PRICES.

SCREENING MACHINERY.




COAL HANDLING MACHINERY.

Address THE JEFFREY MFG. CO., Columbus, O., New York, Chicago, Denver, St. Louis, Buffalo, Philadelphia, Kansas City.

COAL and COKE CRUSHERS.

PURIFIER TRAYS SCRUBBER

John Cabot,
553-557 W. 33d St., New York.

Bristol's Recording
**PRESSURE GAUGE.**
For continuous records of **Street Gas Pressure.**
Simple in construction, accurate in operation and low in price.
Fully Guaranteed. Send for Circulars.
**THE BRISTOL CO.,**
Waterbury, Conn.
Silver Medal, Paris Exposition.

**COAL TAR**
—AND—
**AMMONIA.**
Third and Enlarged Edition.
BY
**GEORGE LUNGE, Ph.D.**
Price, $15. For Sale by
A. M. CALLENDER & CO.,
42 Pine Street, New York City.

**KELLER ADJUSTABLE COKE CRUSHER.**

Strong, Simple, Durable. Will Crush any Size Desired.

C. M. KELLER,
Sec. & Supt. Gas Lt. & Coke Co.,
Columbus, Ind.
Correspondence Solicited.

**Do You Wish to Know**

what size of pipe to use to convey any quantity of gas, any distance, with any loss of pressure and any initial or final pressure? Then use

**Cox's Gas Flow Computer,**

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 6.5 x 8 inches, in cloth case, $2.50. For sale by

A. M. Callender & Co., 42 Pine St., N. Y.

**POOLE ON FUELS.**

THE CALORIFIC POWER OF FUELS.

By HERMAN POOLE, F.C.S.

Second Edition. Price, $3. For Sale by

A. M. CALLENDER & CO., 42 Pine St., N.Y. City.

**BINDER for the JOURNAL.**

Price, $1.00.

A. M. CALLENDER & CO., 42 Pine Street, N.Y.

EDMUND H. McCULLOUGH, President. CHAS. F. GODSHALL, Treasurer. H. C. ADAMS, Secretary. HENRY WHARTON, Assistant Secretary.

**THE WESTMORELAND COAL CO.**

Chartered 1854.

**Mines situated on the Pennsylvania and the Baltimore and Ohio Railroads, in Westmoreland County, Pa.**

POINTS OF SHIPMENT:

PHILADELPHIA, BALTIMORE, SOUTH AMBOY, N. J.,
WATKINS (SENECA LAKE), N. Y.

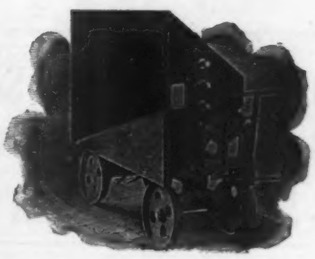
Since the commencement of operations by this Company its well-known Coal has been largely used by the Gas Companies of New England and the Middle States, and its character is established as having no superior in gas-giving qualities, and in freedom from sulphur and other impurities.

**Principal Office, 224 South 3d St., Phila., Pa.**

**THE LINK-BELT MACHINERY CO.,**

ENGINEERS, FOUNDERS, MACHINISTS,

Chicago, U. S. A.



Tilting Coal and Coke Car.

**LINK-BELT** ELEVATING & CONVEYING MACHINERY for HANDLING COAL, COKE, OXIDE, ETC

Tilting Coal and Coke Cars, Breaker Rolls, Power Transmitting Machinery.

Machinery designed and erected to suit existing conditions and available space.

Special Catalogue No. 31 Sent upon Appl'cation.

PHILADELPHIA, LINK-BELT ENGINEERING CO.

**THE SUN OIL CO.**

Crude Oil, Gas Naphtha,
Refined Petroleum, Gas Oil.

Toledo, O., and Pittsburgh, Pa.

**Standard Oil Company,**

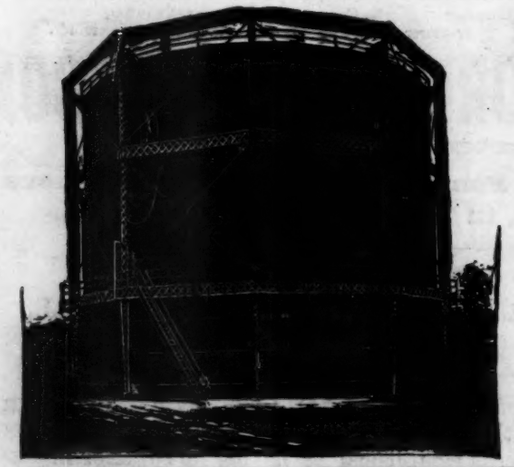
GAS NAPTHA DEPARTMENT.

**GAS NAPTHA.**

**GAS OIL.**

Correspondence Solicited.

26 Broadway, New York City.



## DAVIS & FARNUM MFG. CO.,
**WALTHAM, MASS.**

Principal Office & Works, Waltham, Mass. Boston Office, R'm 18, Vulcan Bldg., 8 Oliver St.

Single, Double and Triple-Lift Gasholders of any Capacity. Tubular, Pipe and Sinuous Friction Condensers of all Sizes.

Steel Tanks for Gasholders, Iron Roof Frames and Floors. Purifying Boxes, Center Seal or Valve Connections, Bench Work, Reversible Lime Trays.

Self-Sealing and Pressed Steel Mouthpiece Lids.

Coke Borrows, Coal Wagons, and all Apparatus Requisite for a Complete Gas Works.

Also, Gas and Water Pipe, Flanged Pipe, Sugar House Work, and Special Castings of all Descriptions.

## BAXTER & YOUNG,
**CONTRACTING AND CONSULTING GAS ENGINEERS.**

Examination and Values Ascertained of Artificial and Natural Gas Properties.

COMPLETE GAS WORKS ERECTED.

Artificial and Natural Gas Mains Furnished and Laid.

GAS PROPERTIES PURCHASED.

OFFICE: WAYNE COUNTY BANK BUILDING, oms 201 & 202. DETROIT, MICH.

## A. E. BOARDMAN, C. E.,
**Consulting and Contracting Engineer.**

Particular attention given to Gas, Water and Electric Plants. Long and successful experience with the problem and practice of

Filtration for Public Water Supply.

BREVARD, N. C.

## JAMES T. LYNN,
**GAS ENGINEER AND CONTRACTOR,**

Wayne Bank Building, - DETROIT.

GAS PROPERTIES PURCHASED.

## Geo. Shepard Page's Sons.
**GAS MACHINERY.**

Correspondence Solicited.

180 Fulton Street, New York City.

## DAVID LEAVITT HOUGH,
Consulting Engineer AND **CONTRACTOR,**

PARK ROW BUILDING, N. Y.

# KERR MURRAY MANUFACTURING CO.

## Latest Design Rotary Exhauster, With Automatic Governor,

## Single or Double-Lift Gasholders,

WITH OR WITHOUT STEEL TANKS.

**Storage Oil Tanks, Condensers and Scrubbers.**

**Purifying Boxes, with Cover-Lifting Apparatus, Center Seal or Valve System Connections and Oxide Elevator.**

REVERSIBLE WOOD PURIFYING AND SCRUBBING TRAYS.

**Mouthpieces, Standpipes, Etc.; in Fact, All Classes of Ironwork for Benches.**

DOUBLE GATE ALL IRON GAS VALVES, 3 TO 36 INCHES DIAMETER.

**ALL SIZES OF STREET SPECIAL CASTINGS.**

# FORT WAYNE, IND.

# BARTLETT, HAYWARD & CO.

## BALTIMORE, MD.

## Triple, Double and Single-Lift Gasholders.

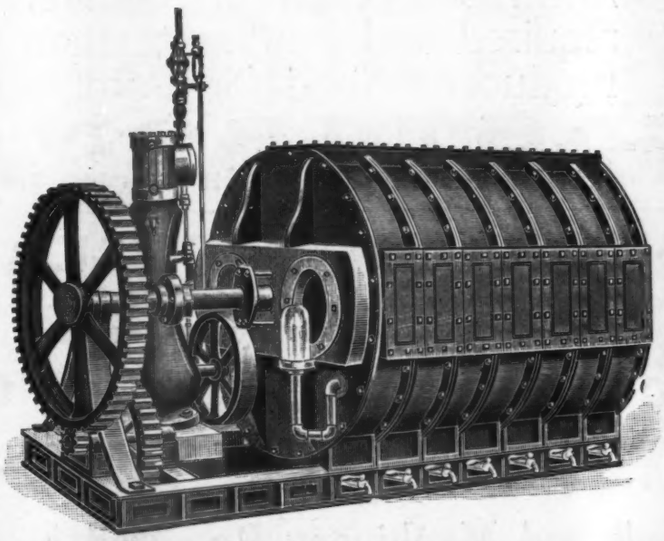
Iron Holder Tanks.

ROOF FRAMES.

Girders.

BEAMS

PURIFIERS.



CONDENSERS.

Scrubbers.

Bench Castings.

OIL STORAGE TANKS.

Boilers.

## PATENT STANDARD WASHER-SCRUBBER.

The best apparatus for the extraction of all Ammonia and a large proportion of Carbonic Acid and Sulphureted Hydrogen. The Scrubber has been materially improved and is provided with patented Wooden Segmental Grids, instead of Metallic Discs, thus reducing the weight on shaft and power for operating same.

## The Wilkinson Water Gas Process.

THIRTY-CANDLE, NON-CONDENSABLE, FIXED GAS. THE MOST SUCCESSFUL GAS PROCESS IN OPERATION.

**MILL'S REVERSIBLE LIME TRAYS.**

Gas Works Designed and Constructed.

## QUINTARD IRON WORKS,

**N. F. PALMER,**

Foot of 12th St. & East River, New York,

MANUFACTURERS OF

**GAS APPARATUS.**

Complete Works Erected.

FREDERICK W. FLOYD, Engineer.

ALEX. C. HUMPHREYS, M.E., M. Inst. C.E. ARTHUR G. GLASGOW, M.E., M. Inst. C.E.

## HUMPHREYS & GLASGOW,

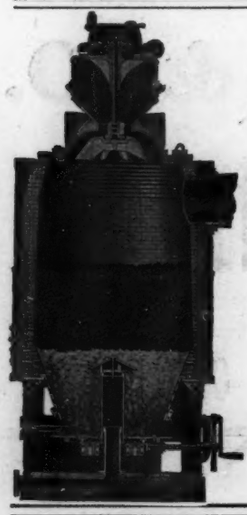
BANK OF COMMERCE BLDG., 31 Nassau Street, New York.

38 VICTORIA STREET, London S.W., England.

CONSULTING GAS AND ELECTRIC LIGHT ENGINEERS.

PROPERTIES PURCHASED.

COMPLETE EXAMINATIONS MADE.



# R. D. WOOD & CO.,

400 CHESTNUT STREET, PHILADELPHIA,

—BUILDERS OF—

## Gas Power Plants with Producers,

The best Producers for either Bituminous, Anthracite Coal or Lignite. Less labor required and less waste than in any other Producer. Send for Pamphlet. : : : :

## CAST IRON PIPE.

HYDRAULIC TOOLS. HYDRAULIC OPERATING VALVES.

# ISBELL-PORTER CO.,

ENGINEERS AND CONTRACTORS FOR THE

## Construction and Extension of Gas Works.

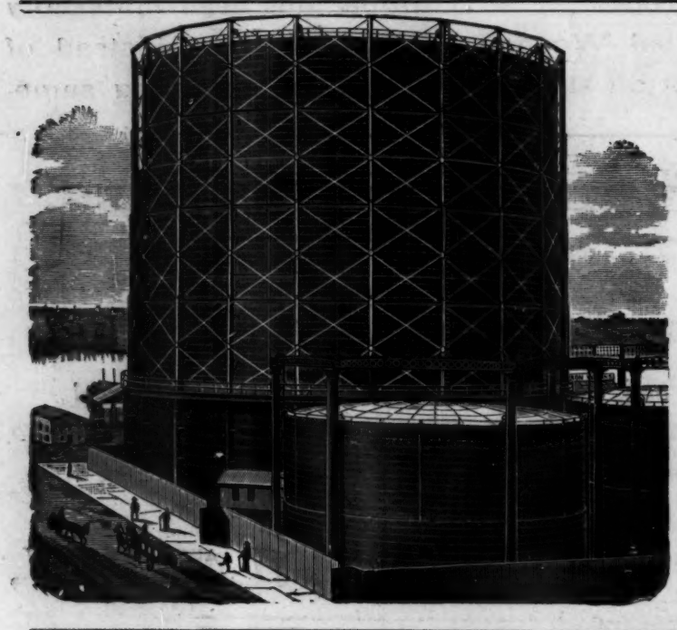
FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

All Ironwork and Machinery Required in a Gas Plant.

Estimates, Drawings and Specifications furnished for the Alteration, Improvement, or Extension of Existing Works or the Construction of New Works.

**245 Broadway, New York City.** —OFFICES— **Bridge & Ogden Sts., Newark, N. J.**



# The Continental Iron Works,

THOMAS F. ROWLAND, President.
WARREN B. HILL and CHAS. H. CORBETT, Vice-Presidents.
THOMAS F. ROWLAND, Jr., Secretary & Treasurer.

**West and Calyer Sts.** (Near 10th & 23d St. Ferries)
NEW YORK, Borough of Brooklyn.

BUILDERS OF

## Gas Holders.

Single and Multiple Section Gas Holders a Specialty.

STEEL GAS HOLDER TANKS.

BENCH CASTINGS, RETORT LIDS.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, Etc.

## Self-Sealing Retort Mouthpieces & Lids

For Round, Oval, or "D" Retorts.

ILLUMINATING GAS! FUEL GAS!

## THE LOOMIS PROCESS.

Now in successful operation at Works of John Russell Cutlery Co., Turner's Falls, Mass., and Henry Disston's Son's Saw Works, Tacony, Pa.

**The Cheapest Gas Generating System in the World.**

Plans and Estimates Furnished.

**BURDETT LOOMIS, - - Hartford, Conn.**

## The Gas Engineer's Laboratory Handbook,

By JOHN HORNBY, F.I.C

Price, $2.50.

A. M. CALLENDER & CO., 42 Pine St., N. Y. City.

# THE STACEY MANUFACTURING CO.,

## The Chollar System of Gas Purification,

## WITH DUPLEX BY-PASS VALVE CONNECTIONS.

OFFICES:

No. 239 Mill Street, CINCINNATI, OHIO. 'Phone, West 690.

PLANS, SPECIFICATIONS AND ESTIMATES CHEERFULLY FURNISHED.

# RITER-CONLEY MFG. CO.,

## GASHOLDERS, with or without Steel Tanks.

Purifiers, Condensers, Scrubbers, Oil Tanks, Smoke Stacks.

**STEEL ROOFS and BUILDINGS.**

PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.

GENERAL OFFICE: Pittsburg, Pa. EASTERN OFFICE: 39-41 Cortlandt St., New York City.

# WM. HENRY WHITE,

No. 62 Wall Street, - - - New York City,

ENGINEER AND CONTRACTOR FOR THE

ERECTION AND EXTENSION OF

## GAS, WATER, AND ELECTRIC LIGHT WORKS.

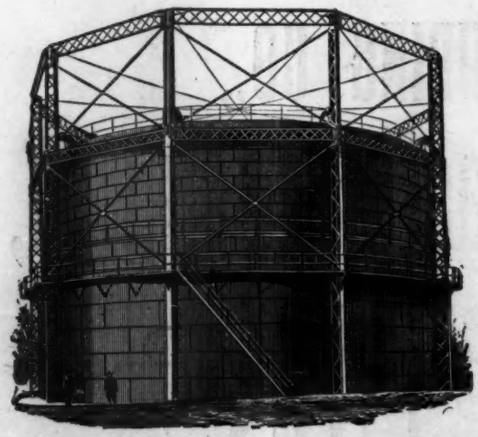
Correspondence with Gas Companies contemplating extending or improving their Plants respectfully invited.
Plans and Estimates Furnished.

# 1902 DIRECTORY 1902

## OF AMERICAN GAS COMPANIES.

Price, - - - - - - - - - $5.00.

**A. M. CALLENDER & CO., - - No. 42 Pine Street, New York.**



# 1842 ※ Deily & Fowler, ※ 1902

## LAUREL IRON WORKS.

Office, No. 39 Laurel Street, Philadelphia, Pa.

BUILDERS OF

## Gasholders

Single or Telescopic. With or Without Iron or Steel Tanks.

OIL TANKS, WATER TANKS, AND GENERAL WROUGHT IRON WORK

The order for this Triple-Lift Holder and Steel Tank was received by the Logan Iron Works from the Union Gas Light Company, of East New York. The contract was completed and the Holder was in actual use in 90 days from receipt of order. Capacity of Holder, 500,000 Cu.Ft.

## LOGAN IRON WORKS,

**Brooklyn, N. Y.**

MANUFACTURERS OF

Single or Multiple-Lift

## GASHOLDERS,

Complete with Steel Tanks.

**BENCHES, SCRUBBERS,**
**CONDENSERS,**
**PURIFIERS, IRON ROOFS,**
**Self-Sealing Retort Lids,**
AND ALL PARTS OF
GAS WORKS APPARATUS.

Contractors for
Complete Works.

ALSO, SOLE MANUFACTURERS OF

**C. W. BLODGET'S**
HOT GAS SCRUBBER.

# PRACTICAL PHOTOMETRY,

A GUIDE TO THE STUDY OF THE MEASUREMENT OF LIGHT.

By WILLIAM JOSEPH DIBDIN.

With Numerous Illustrations. Price, $3.00.

A. M. CALLENDER & CO., 42 Pine Street, New York City.

Established 1854.

# D. McDONALD & CO.,

MANUFACTURERS OF

WET AND DRY METERS, STATION METERS AND METER PROVERS.

ALSO MAKERS OF

# THE GLOVER PREPAYMENT METER.

The amount of gas delivered for the coin can be instantly and positively changed without removing the meter or replacing any parts.

The gas registered agrees absolutely with the amount purchased by the coin.

WE HAVE MADE AND SOLD IN THE UNITED STATES

**OVER 70,000 OF THESE METERS,**

ALL OF WHICH ARE GIVING PERFECT SATISFACTION.

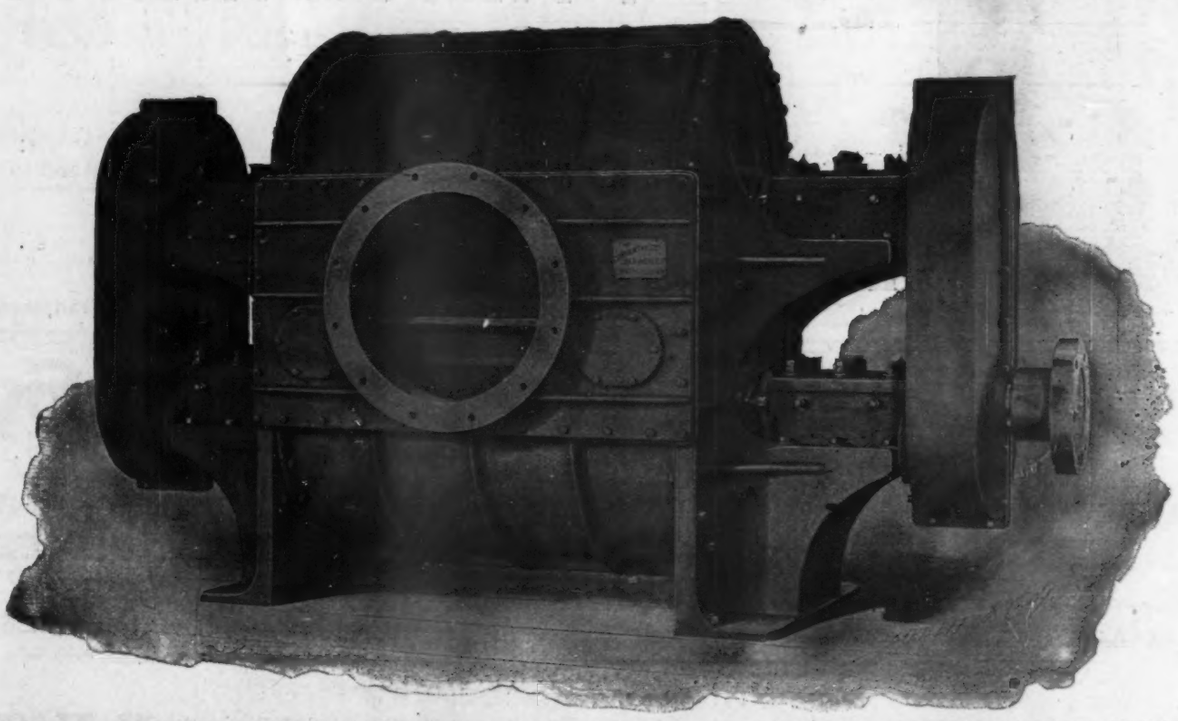
Correspondence Solicited.

561 West Forty-seventh Street, NEW YORK. | 51, 53 & 55 Lancaster Street, ALBANY, N. Y. | 34 & 36 West Monroe Street, CHICAGO.

# THE CONNERSVILLE BLOWER CO.,

MANUFACTURER OF

ROTARY POSITIVE PRESSURE GAS EXHAUSTERS, BLOWERS AND PUMPS.



HORIZONTAL OR VERTICAL, IN CAPACITY RANGING FROM 9,000 to 1,800,000 CU. FEET DISPLACEMENT PER HOUR.

CONNERSVILLE BLOWER CO., Connersville, Ind. EASTERN SALES OFFICE: 95-97 Liberty St., New York City.

# NATHANIEL TUFTS METER CO.,

ESTABLISHED 1849.

**8 MEDFORD STREET, BOSTON, MASS.**

Consumers' Dry Gas Meters.
Station Meters of Any Capacity.

## PREPAYMENT GAS METERS.

# MARYLAND METER CO.,

**BALTIMORE, North and Saratoga Streets.** **CHICAGO, 88 to 92 Jackson Boulevard.**

**CONSUMERS' AND STATION METERS, PRESSURE GAUGES, ETC.**

SPECIAL ATTENTION GIVEN TO ALL REPAIR WORK.

**"Have you Seen our Complaint Meter?"**

# THE KEYSTONE PREPAYMENT

**IS**

An Accurate Registrar,
A Sure Shut-off,
An Ideal for Easy Adjustment,
A Model of Simplicity,
A Paragon of Excellence, and
A Mighty Good All-round Meter. Get Acquainted with it.

**Keystone Meter Co.,** ROYERSFORD, PA.

WIESTER & CO., 22 Second Street, San Francisco, Cal.

# FIELD'S ANALYSIS
## For the Year 1901.

An Analysis of the Principal Gas Undertakings in England, Scotland and Ireland. Being the 33d Year of Publication. Compiled and Arranged by

**JOHN W. FIELD,**

**Secretary and General Manager of The Gas Light and Coke Company, London.**

Price $5. For Sale by

**A. M. CALLENDER & CO., - No. 42 Pine Street, N. Y. City.**

# AMERICAN METER COMPANY,

NEW YORK, PHILADELPHIA, SAN FRANCISCO.

# PREPAYMENT METERS.

THEIR CONSTRUCTION IS SUCH THAT THEY MAY BE READILY READJUSTED WHEN THE SCALE OF GAS RATES IS CHANGED.

# HELME & McILHENNY,

Established 1848. 1339 to 1349 Cherry Street, Philadelphia, Pa.

MANUFACTURERS OF

Wet and Dry Gas Meters, Station Meters, Provers, Gauges, Etc.

METERS REPAIRED

**PREPAYMENT GAS METERS.**

**Our Own Patents. Strong. Simple.** PROMPT ATTENTION. CORRESPONDENCE SOLICITED.

# METRIC METAL COMPANY,

MAKERS OF

GAS METERS for NATURAL and ARTIFICIAL GAS.

Special Attention given to Repairing METERS of all Makes.

**FACTORY AT ERIE, PA.**

**EXCERPTS FROM DECISIONS**

—OF THE—

## BOARD OF GAS COMMISSIONERS of the COMMONWEALTH OF MASSACHUSETTS.

MR. E. H. YORKE, NEW HAVEN, CONN., Dec. 1, 1898.

Dear Sir:—I am in receipt of a copy of "Excerpts from the Decisions of the Board of Gas Commissioners," which is a handy compilation in book form of extracts from the most recent decisions of the Gas Commission of Massachusetts.

I note that most of these extracts are broad and safe-guiding precepts, which apply with equal force to one Company as to another. The 13 years' existence of the Board of Gas Commissioners with its unusual opportunities for acquiring information, have justly made it a high and safe authority in all matters pertaining to the management, obligations, and rights of Gas Companies. Your little book will serve as a valuable reference library in settling legal complications which often arise between a Gas Company and its customers.

Yours truly, (Signed) F. C. SHERMAN, Superintendent.

A 28-page Pamphlet containing the cream of this Board's decisions as to the proper management of Gas Companies.

Compiled by E. H. YORKE. Price $1.00. Address

**A. M. CALLENDER & CO., - No. 42 Pine Street, New York.**

The Advertisement of

THE WESTERN GAS CONSTRUCTION COMPANY, Engineers and Builders,

Improved Double Superheater Lowe Water Gas Apparatus—Manufacturers of General Gas Works Machinery—Builders of Gas Works,

FORT WAYNE, IND.,

Occupies this Space Every Alternate Week.

# JOHN J. GRIFFIN & CO.,

559 W. 47th St., New York.

1513 to 1519 Race St., PHILADELPHIA, PA.,

34 W. Monroe St., Chicago.

MANUFACTURERS OF

# GAS METERS,

## Station Meters and Experimental Apparatus of Every Description.

PROMPT ATTENTION GIVEN TO ALL REPAIRING.

## OUR SPECIAL NATURAL GAS METER

Is the Best ever offered. Over 40,000 now in use.

# The Positive Prepayment Meter.

**Positive Advantages:**

The Income is Quick and Sure.

IT IS

**Better than C.O.D.,**

As Gas is Paid for Before Delivery. : : :

**There is Money in it** ☞

For the gas man.

IT WILL GET NEW CUSTOMERS.

It will KEEP the ones you have.

**Negative Advantages:**

No "Deposit" is Necessary to Start Business with a new customer. : : :

NO CUSTOMERS ARE LOST on that account.

No Time Lost Making Out Bills.

No Money Lost on account of Unpaid Bills. :

No Disputes on Account of Bills.

THE PREPAYMENT SYSTEM IS PROFITABLE FOR THE GAS MAN AND PLEASANT FOR THE CONSUMER.

NEARLY 100,000 OF THESE METERS ARE IN USE IN THE UNITED STATES.

SEND FOR OUR BOOKLET.